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FIRST PRINCIPLES IN RAILROAD MANAGEMENT.

By Benjamin Reece.

WHEN we consider the existing social unrest, the vagaries of popular judgment, and the violent oscillations of political movements, we may well determine that for the past few years the first principles of government must have been grotesquely violated or ignored.

Whether we observe the financial, commercial, industrial, or moral development of the age, the same absence of equilibration is everywhere felt and observed. While the mechanic has proceeded with his marvelous triumphs over the material world, the statesman has proved his incapacity to properly conserve the industrial and social forces of our people.

Is it not inexplicable that the marked advance recently made in scientific discovery and mechanical invention should be attended with ebullitions of passion and unrest, threatening the integrity of existing social systems? The utter incoherence of political thought and expression, as made manifest in the declarations of party platforms, in the deliberations of radical clubs, and in the spasmodic appearance of the "Common Weal" and kindred bodies, gives proof of the bewildered state of the popular mind.

So deep-seated are these perturbations that no remedial scheme is too fantastic or absurd to find exponents and adherents, and unfortunately most of the political leaders who should give direction to the public thought are either abjectly silent or actively encouraging such vagaries, and, by giving apt and forcible expression to the existing prejudices of the voter, hope to receive the rewards of leadership and

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the emoluments of office without the labor of conscientious study and the exercise of the vigorous energy required to divert the flood-waters of popular error into the channels of wise and enlightened economic thought. Still another large portion of the community, reflecting the arguments presented and distrusting the methods proposed, are conscious of coming changes.

The complex and intricate relations which have arisen in the social group since the introduction of steam in the last century can hardly be comprehended, much less analyzed. The forces of production and distribution have been completely revolutionized. Machinery with its million workers has taken the place of the master workman, journeyman, and apprentice of a past age. Less than a century ago America was as far distant from Europe in point of time as in the days of Castilian glory; to-day, by railroads, telegraph lines, and ocean steamships, the communities of the earth are being gradually united into one commercial and interdependent whole. This tendency to union the politician has vainly sought to prevent by the substitution of artificial legislative barriers for the natural ones which the mechanic has overthrown. But all such effort must prove abortive, for the investments of idle capital in foreign lands, the further improvements and cheapening of transportation, and the greater enlightenment of the people are constantly checking the reactionary spirit which seeks to revive the isolation and provincialism of the period which preceded the use of steam. More and more is the political idea being outgrown. The attacks of predatory peoples are no longer feared, and invasions by foreign nations are too remote to be considered, except by those who look to the activities of war as a convenient escape from the social unrest and industrial turmoil which their legislative blunders have engendered.

The passions and animosities of men, which in preceding generations were directed against other tribes and States, are now directed against industrial groups. So the spirit of comradeship and loyalty which once united the members of the tribe and afterwards the State is gradually being transferred to the same industrial groups.

That the militant spirit in so marked a degree should continue to live and coexist with the highly differentiated industrial development of the age is in itself unaccountable, and can be explained only by the inference that the increased material possibilities of the age have not been accompanied with the corresponding moral restraints which that condition naturally imposes. On every hand we hear the breath of war and observe the manifestations of its spirit, and the growing temper and bitterness of industrial groups augur no good for the future of our development.

In the early days of the republic it was thought that our form of government and popular institutions were of themselves the guarantee of industrial peace and insured the happy contentment of our people. That illusion has passed away, and in no civilized country of the globe have the lines been more sharply drawn or the signs of impending conflict been more threatening. By physical force the employee has sought to control capital, and by the force which resides in wealth capital has attempted to coerce labor. Legislative majorities have imposed onerous and unjust restrictions upon railroads, and even political campaigns are directed to arouse the selfish instincts of the masses by special appeal and promise of laws affording advantages to the particular groups whose votes are sought. There is too little of that dispassionate discussion and intelligent inquiry as to measures of justice which will best conserve the interests of all.

Most of our laws in their essence are derived from those customs which came down to us from the feudal ages. Having their origin in an age of primitive nature and unsettled estates, they were, by environing conditions, measurably fitted for the early settlement and rapid development of our boundless western domain. The self-reliance, courage, migratory tendencies, and warlike energy of the early feudal group are seen again in the early western settler, who developed and exhibited the same traits, which he directed to the subjugation of nature in its boldest and wildest aspect. But no sooner had this settlement been accomplished and occupancy become complete than we found ourselves beset with the same social problems and industrial turmoils which the statesmen of Europe had so long labored to correct.

The feudal system was essentially founded on force. For the preservation of order in our early communities successive decisions of the courts, reinforced by statutes, have crystalized many of the old feudal forms into law.

It has frequently been the part of legislation to perpetuate disorder by preventing those movements and arresting those activities which are essential to social and economic readjustments.

As illustrating my meaning, let me relate a personal experience. While in Birmingham, Ala., during an active period of railroad construction some few years ago, I spent considerable time in the switching-yards, which were being reconstructed and enlarged. During one of these visits a track gang composed of negroes was directed to go and bring a frog for use in a turn-out. Six men equipped with three bars started to the store-yard, and I followed to see them work. After finding the frog of the required angle, the three bars were placed under the frog so that the six men could carry it by means of the extending ends of the bars. The rascals had evidently learned by experience

that the further removed the load was from their end of the bar the less the burden they would be required to carry. So, after the bars were placed, the projecting ends of each bar were measured and equalized, awarding to each his fair share of the load. But no sooner had the frog been lifted from the ground than by a series of tugs and jerks each man sought to lengthen his end of the bar. Those who had lost ground in the contest refused to proceed further with the frog, and it was again lowered to the ground, and the ends of the bars were remeasured and readjusted, only to be disarranged as before. In theory these men were willing to be fair, but the temptation to gain the advantage was too much for them, and, after frequent repetitions of the scene described, consuming some ten minutes or more, the foreman appeared and with an oath commanded the men to move on quickly with the frog. So on they marched, each with the length of bar he happened to secure at the time the command was given. And the big strong fellow who had successfully jerked a goodly portion of the bar from his smaller partner in work on the other side of the frog strutted along with a light heart and a light load, grinning with satisfaction as he watched his partner tugging and groaning under his unequal burden.

Has not this been measurably true of many of our laws? Have not much of the unrest and discontent which we observe arisen from institutions which have grown up from the hasty and ill-advised settlement of social conditions by laws in which fairness and justice were sacrificed to secure prompt and enforced orderly action?

It is not to be supposed from what has been said that we have created and developed an industrial system which, as a people, we are morally unfitted to control. But it does imply that in the mighty changes which have been involved a certain freedom of experimental conduct must be permitted, so that the new relations will be properly discerned, thereby leading to normal re-adjustments.

As legislation has caused confusion by the repression of actions which it condemned, so has it caused equal disorder by stimulating activities which met with its approval. No sooner were the advantages of railroads fully understood than laws stimulating their construction were enacted in almost every State, and many of the existing evils in railroad management are traceable to the presence of such laws upon the statute-books. When the early roads had been united into continuous lines of commerce, there came the occupation of distinct territory. Then the invasion by the roads of each other's territory for the avowed purpose of dividing the traffic gave rise to rate-wars, which threatened the integrity of all railroad investments. When the disastrous results of this reciprocal rapine had been experienced, truce after truce

was patched, only to be broken by the treachery of those who hoped to gain by craft and evasion what they had failed to secure by open war. After frequent intermittent struggles between the roads, the pool was organized, as affording a central source of power which would assign to each line its proper share of earnings. Meanwhile the shipping and travelling public had been educated through the means of these very wars to believe that in a multiplicity of lines rested the true basis of competition with low cost of service, and the pool, instistituted for the purpose of conserving great properties, was mistakenly regarded as the instrument of extortion and injustice. The effect was two-fold. Local aid was everywhere offered for the construction of competing lines, while pools and similar combinations were decried and ultimately prohibited by federal statute. It is worthy of note that the failure of the Inter-State Commerce Act to prevent discrimination by rebates and drawbacks has so modified popular opinion that a large majority of the State railroad commissioners, as well as the Inter-State Commerce Commission, have declared in favor of a modified pool; and the last house of representatives passed such a measure, which failed in the senate only because it was not reached on the calendar before adjournment.

But unfortunately a restoration of the pool will not reach the cause of trouble. It will only correct the evil effects of an existing cause, and as such can only palliate and thereby make the cause more persistent in its operation. I refer to the loose laws which permit the construction of new railroads for the profits arising from construction and the marketing of securities.

The public clamor for more railroads is predicated on the assumption that a multiplicity of lines intensifies competition and tends to lower the cost of service. And yet it stands to reason that any increase of lines in excess of the requirements must ultimately increase the cost of transportation, by compelling the maintenance and operation of more lines than the business warrants.

That a healthy and prosperous condition of a community is not dependent upon the existence of competing lines of railroad is well attested by the case of Connecticut, which is almost solely dependent upon the New York, New Haven and Hartford Railroad for its transportation. While practically monopolizing the business of the State, this road has spent millions of dollars in the improvement of its line and the bridging of highways to secure the public safety. Its passenger service in the number and average speed of trains is unexcelled, while the rate of passage is less than 1¾ cents per mile. The activity and growth of its many flourishing towns are convincing proofs of the utility and cheapness of the freight service, and with all this the sec-

tion laborers receive exceptionally good wages, while 10 per cent. annual dividends to the investors have been the rule. That lines having similar advantages of position have used them unwisely for purposes of extortion is also true,—with the resultant construction of competing lines to lower the rates and divide the traffic.

The principles of justice and fair dealing, when fairly understood, operate as an irresistible force in the guidance of the public conscience, and, when we note the gradual subsidence of the bitter prejudices against pooling, it must be clear that a better realization by the people of the evils of over-construction will soon remove that danger.

The civil engineer, in building his bridge, knows that in providing for his strains every pull involves a push and every push a pull, and thus, through the means of stress, rods, and chords, the numerous members act together, and safely bear the loads they are required to carry. Here then is suggested the true basis of enlightened railroad management founded on justice. It is no more and no less than the equilibration of conflicting interests.

The railroad manager during the war was the pushing, driving organizer. When the panic of 1873 came, a new danger arose, and new qualities of management involving financial ability were brought into requisition. With the present dangers, including hostile legislation, a distrusting public, and restless employees, still higher qualities are required. The manager of the future must learn that success depends upon the prosperity of the communities it serves, and that to charge unduly for services performed must react in decreasing business, which in its logical results means eventual dissolution. Likewise in dealing with employees. Good men are not averse to strict discipline, *if justice is observed;* but the effect of ill-considered and capricious judgment is demoralizing in the extreme. The tendency of the day shows that the true relations existing between the railroads and their employees are being earnestly studied, with the prospects of a better understanding.

The railroad problem is to be solved by the maintenance of good faith between the railroads themselves, by the growth of reciprocal feelings of good-will between railroad and patrons, and by the restoration of mutual confidence and dependence between it and its employees. Each relation is a dual one, and can be arrived at only by a recognition of the interdependent relations. Failing in this, order will eventually be restored through the bitter experiences and waste of opposing and counteracting forces, which, if working in harmony, would conserve the prosperity of all.

THE LEGISLATIVE REGULATION OF RAILROADS.

By Albert Fink.

BEFORE the present Inter-State Commerce law was enacted, some of the more stringent provisions originally contained in it were materially modified. In fact, there is every reason to believe that, without such modification, the law not only would have proved utterly ineffective, but would have inflicted incalculable injury upon all the commercial interests of the United States. That such beneficial changes were made in the legislation originally contemplated is generally admitted to have been due to the educational campaign conducted by Mr. Albert Fink, who on a number of different occasions appeared before committees of congress and other public bodies with a vigorous and convincing exposition of the nature and operation of the unwritten but all-powerful natural laws which determine the tariffs, methods, and policies of the transportation companies of all the world. No more important contribution to the solution of the railroad problem has heretofore been made, or is likely to be made hereafter, than that which may be gleaned from the arguments and expert testimony of Mr. Fink, as contained in the reports of these congressional hearings, and from his occasional contributions to the journals of the time. The extracts hereinafter presented have been carefully selected from these sources, and, so far as practicable, have been arranged to present a coherent and consecutive argument. The striking accuracy with which many of the predictions of Mr. Fink have been fulfilled in the progress of events during the eight years and more in which the Inter-State Commerce act has been the law of the land would seem to render the republication of his observations a matter of more than ordinary interest and importance at the present time.—THE EDITOR.

It is first necessary to clearly understand what are the evils to be remedied. It will be found that the complaints of the public are directed against the commercial management of the railroads,—the charges made for transportation service, or the adjustment of the railroad tariffs. We hear of no public complaint against the technical management of the roads ; and it may be said with some pride that, as regards the accommodations and facilities furnished to the American people,—the safe and prompt and economical conduct of the passenger and freight traffic,—the management of the railroads in this country is

superior to, or, to say the least, not surpassed by, that in any other country. A passenger may traverse the continent, almost enjoying the comforts of a home. Freight is being shipped from and to the remotest parts of the continent with great expedition, and without subjecting the shipper to the many annoyances and inconveniences which are experienced in other countries. These results have been secured partly through the consolidation of a number of roads into long lines, or large systems under one control, or through the coöperation of the many yet existing separate railroad companies, by which unity of management, so necessary for the proper transaction of business, has been practically secured.

The solution of the railroad problem in this country is, therefore, confined to the satisfactory settlement of the question of tariffs, and may be said to consist in the attainment of the following objects:

(1) To establish a reasonable and equitable railroad transportation tariff for the whole country.

(2) To maintain this tariff with the greatest possible degree of permanency.

I purposely state the problem under these two separate heads, in order to simplify its consideration.

The solution of the first part of the problem involves the consideration of this question: "What is a reasonable, equitable, and justly discriminating railroad tariff?" It is held by some that a tariff, in order to be reasonable, must be made in exact proportion to the cost of the service performed; but then the question arises: "What is the cost?" and this is a very difficult question to answer. In some instances the cost of transporting one ton of freight one mile may only be 1-10 cent, and at the same time, on the same road under different conditions, it may be 10 cents or more. To make even an approximate estimate of the cost in any given case is a work of great difficulty and complexity, and strictly to comply with the condition that a railroad tariff, in order to be reasonable, must be based upon actual cost, and made in exact proportion to cost, is an impossibility.

It is equally difficult to answer the question: "What constitutes just and unjust discrimination?" It is conceded that discrimination in transportation charges must be made; but when are such discriminations just, and when unjust? In order to ascertain this we may apply this test: a tariff is just when, under its operation, one shipper is not injured at the expense of another, and when like charges are made for like services. It would, however, be vain to search for one general principle applicable to all cases that occur in daily practice, according to which we could, *à priori*, decide whether a railroad tariff complies with these conditions or not.

For example, a railroad company may charge twice as much to one shipper as to another for the same kind of goods shipped from the same point to the same destination; yet this in itself is not proof of unjust discrimination, as the quantity shipped by one may be comparatively small, and the actual cost of carrying the smaller quantity may be twice as much per 100 lbs. as that of carrying the larger quantity. The value of the articles to be transported, and their prices in the different markets in which such articles are to be exchanged, determine most frequently the transportation charges, regardless of the cost to the carrier or distance to which the articles are to be carried. So long as there is any profit at all to a railroad company in moving certain articles of commerce, no matter how small that profit may be, —to meet competition either of markets or of other transportation lines,—railroad companies should not be obliged to refuse to carry such low-priced freight, because they cannot afford to do the whole of their business at so small a profit. They must be allowed to make greater charges on articles which can bear higher rates of transportation, and disregard the principle that charges should be in exact proportion to cost.

Either they must do this, or the articles which do not stand the higher charges of transportation cannot be moved at all, and the profit which could have been derived from their carriage would most likely be replaced by a further increase in the charges on those articles which can stand higher rates. In all the business transactions of a common carrier, as well as in all other commercial transactions, the laws of trade and commerce, of demand and supply, ought to be allowed to have their full influence; and hence they must have a most important bearing upon the construction of railroad tariffs. If these laws were disregarded, it would soon be discovered that railroads could not be operated at all, or that their usefulness to the public and to their owners would be immensely curtailed. Now, as railroads were not built for the mere purpose of carrying out abstract principles, but for the purpose of making them subservient to the wants of the people, facilitating trade and commerce, and developing the resources of the country, it follows that the great commercial principles—those that give existence and life to the roads—become paramount, and that the "pro rata principle," or the "cost principle," can be applied, if at all, only in so far as it does not come in conflict with the recognized laws of trade and commerce.

From these considerations it will appear that transportation tariffs cannot be established by simple arithmetical or mathematical rules; they require the application of a number of principles, all correct in themselves, to a great variety of ever-changing facts. This is neces

sarily the work of experts, and not the work of legislative departments of government. All attempts to lay down specific rules for the regulation of tariff have heretofore failed.

To protect the people against extortion or unjust discrimination of common carriers, you cannot devise or formulate a more precise and definite law than the common law, which embodies the experience and wisdom of past ages, and which, I am convinced, cannot be improved. It guarantees to the people reasonable and just rates of transportation, and necessarily leaves to the courts to decide what constitutes reasonable and just transportation charges. These are questions that can be decided only after a full consideration of all the facts controlling each case.

Owing to the commercial nature of the transportation business, the laws of trade and commerce, which should govern the management of that business, come, under certain circumstances, in direct conflict with the duties of the common carriers as public servants. The spirit embodied in the common law can be put into practical execution only by restricting or regulating to a certain degree, the operation of the commercial laws,—the law of competition, as applied to the business of the common carriers themselves. It cannot be expected that a number of public servants, when engaged in competitive struggles with each other,—in other words, when engaged in a free fight,—could perform their public duty as common carriers, and guarantee equal and just rates of transportation to all shippers. Such guarantee can be given only when these public servants are made to act in concert in all matters relating to their public duty,—the establishment and maintenance of reasonable and just transportation tariffs. But, if the public prefers that the laws of competition should remain in full force as between these public servants, it must dispense with the enforcement of the law regulating common carriers, and be satisfied to endure the evils which result from the violation of this law,—*viz.*, unjust discrimination, and constant fluctuations in the transportation charges.

The difficulties do not arise from the fact that there are not properly any well-considered and satisfactory tariffs of transportation for the Inter-State traffic of the country, but from the fact that these tariffs are, in most cases, utterly useless, because they are not carried into practical execution. They are often disregarded almost as soon as made. Each company may change or abolish them at pleasure; and from this state of affairs result all the evils of the transportation business,—the general confusion in transportation rates, unequal charges to shippers at the same locality, unjustly discriminating rates between different localities, uncertain and constant fluctuations in the transpor-

tation rates. If therefore, it be desired to remove these evils, it becomes necessary to consider first, the causes which prevent adherence to the proper and just tariffs; and the question has to be answered: Why are the proper tariffs not enforced?

Simply because there is no authority in this country, no power to enforce them. Each railroad company is at liberty to deviate from the established tariff whenever it pleases, although it may have voluntarily given its consent to it and agreed to maintain it; any one of the companies may, and frequently does, enter into secret arrangements with shippers, and reduce the rates, in the hope of procuring a larger amount of business than it otherwise could obtain, or of securing some other advantage over its competitors. No sooner is it discovered that one company engages in this practice than the others must and do follow. No sooner has the tariff in any one city been disturbed than the tariff in other places must necessarily also be disregarded. Owing to the mutual dependence of tariffs,—a feature of the transportation business to which I shall more particularly refer hereafter,—a change at one important point must be followed by a general readjustment throughout the whole country, or through a large section of the country.

Under the process of underbidding, heretofore so generally practised by competing railroad companies,—a practice always encouraged by the shippers, and incorrectly called competition,—no just and equitable tariff can be maintained. I say competition is not a correct name, because legitimate competition can always be carried on openly and above board; the process here described, when competitors are under an agreement to maintain the same tariff, is simply a process of cheating and deceiving, and ought not to be dignified by the name of competition.

The rates at local points are under the control of a single railroad company, while at competitive points they are not controlled or controllable by any one company. The proper and established tariff can only be maintained by the railroad companies acting collectively, as one party. In the absence of this necessary coöperation between all the companies which are in a position to influence, change, or altogether annul such tariffs, the abandonment of the best-regulated tariffs, is unavoidable; and, without their strict maintenance, chaos and unjust discrimination must reign supreme.

No provision is made in this bill looking to coöperation between railroad companies, as a necessary condition toward the attainment of its object. It not only does not authorize such coöperation, but, strange to say, it actually forbids all combinations between railroads by which they have heretofore been enabled to maintain at least some degree of

system and order in the conduct of the transportation business. Moreover, this bill is to do away with the good that has already been accomplished, and to send us back into the chaos from which we are just now emerging. It professes to undertake the prevention of unjust discrimination, and yet it says to the railroad companies: you are forbidden by authority of law to take the proper and necessary steps to obviate and remove this unjust discrimination.

All legislation for the past 40 years on the subject of railroad tariffs has been futile, because legislators have failed to comprehend and to recognize the true nature of the subject with which they attempted to deal. They have directed their laws to the suppression of the outward symptoms of the disease, instead of to its cause. The true cause of the evils to be remedied lies in the separate action of a great number of independent competing roads, no one of which, by its single efforts, can remove the evils. Any legislation, to be effective and successful, must deal with the system of railroads as a whole; in other words, it must look to the combination of all the roads, so as to make them, in effect, act as one road, so far as their duty as public servants requires them to maintain just and equitable rates of transportation, and prevent unjust discrimination.

The railroad companies have endeavored to secure unity of action by voluntary coöperation in all matters in which it is absolutely necessary for the proper management of the roads, in the interest of the public, as well as in the interests of the proprietors of the roads. But this coöperation has been most inefficient in all matters relating to the uniformity, equality, and permanency of railroad tariffs, although in other respects, as already mentioned, it has been very successful.

It is on account of the great complexity of the tariff problem that this voluntary coöperation has not met with better success, and not for want of effort or desire on the part of the railroad companies to control it; although the public, ignorant of all the difficulties to be overcome, presume to hold each separate road responsible for the working of the whole system. The difficulty, however, has been not so much in agreeing upon the proper tariffs as in carrying them into practical effect. The necessary means and machinery for that purpose have not been adopted, and there is no authority to enforce such agreements.

The managers of roads meet in convention, and make agreements which are broken before they disperse. Every one who has paid the least attention to this subject is familiar with these unsuccessful efforts. The press of the country chronicles almost daily some conference held by officers of railroad companies, or some agreement made, and on the following day it chronicles its violation or discontinuance.

During the last few years, however, some progress has been made

toward a closer and more effective coöperation. Associations of railroad companies have been formed, with a proper organization, through which it was made at least possible to control the important tariff question. I do not mean to say that perfection has been reached in this respect, because much remains to be done; but cases of violation of the tariff rates, as far as the trunk lines can exercise their influence, are now the exception, and not, as heretofore, the rule. In my judgment, the only measure now wanted in order to give permanency to the operations of these associations is recognition of the same as necessary and beneficial, giving legal force to the voluntary agreements between its members, with the view of carrying out the objects of the association,—namely, the establishment and maintenance of reasonable and non-discriminating transportation tariffs. If congress would pass a law to this effect, I would consider the whole railroad problem in this country settled, and upon truly American principles. It would allow the proprietors of the railroads to manage their own affairs, which they are much better able to do than a centralized government would be, and at the same time it would restrict the operation of each individual road under the legalized coöperative system to the extent necessary in order to carry out the intent of the law which regulates the conduct of common carriers in their capacity as public servants.

I am aware that objections will be raised to the proposed plan on the ground that it will restrict competition. It will, of course, be impossible to adopt any remedy that would do away with unjust discriminations and fluctuating rates, without restricting at the same time, to a certain degree, the strife—but not the competition—between railroad companies. It is just as impossible that the unrestricted strife between railroads, improperly called competition, could be continued, and at the same time equitable, permanent, and discriminating rates of railroad transportation could be secured to the public, as it is to mingle fire and water into a homogeneous mass. The existence of one excludes the existence of the other. It is either strife between these common carriers—or public servants—and all its attendant evils, such as unjust discriminations and fluctuating rates; or it is coöperation and unity of action in all matters relating to the competitive tariffs, resulting in permanent, just, and equitable rates. The people will have to choose between the two. Each of these plans has its advantages and disadvantages. In this, as in all other human affairs, perfection is not possible, and the question simply is: Which is the lesser of the two evils? It would be a comparatively easy matter to establish proper transportation tariffs, if each separate carrier could make its own without regard to others,—a condition of things which is generally supposed by the public to exist. The fact, however, is that only

upon a very small portion of its traffic can a railroad company control its tariffs.

The competitive railroad tariffs for Inter-State commerce are not, as is so generally supposed, under the absolute control of railroad managers: the carriers by water routes really establish these tariffs, and the railroad managers have nothing to do but conform to them. The water routes not only control the tariffs of their immediate rail competitors at points where they can render like service to the same people, but their influence reaches, directly and indirectly, to the remotest parts of the country. Compared with this natural powerful regulator of railroad transportation tariffs, the efforts of State or congressional legislation to prevent extortionate charges appear to those who are fully conversant with the subject as perfectly useless; and the declamations against the baneful effect of the so-called railroad combinations appear simply as idle talk.

While the water routes exist only between Chicago and New York, the effect upon transportation rates is felt all over the country, by reason of the competition between the railroads. No combination of the railroads can suppress this competition. It could only be done if the railroads were all owned by one party, and were operated in one interest. But, as it is, they all have separate interests, and each one, in guarding its own, keeps up this competition; and the rates, even when agreed upon between themselves, are fixed by competition. This, unfortunately, is not understood by the public. It is generally believed that, when competing railroads agree upon uniform rates, this excludes competition. This is not the fact. The effect of water competition is felt not only east of the Mississippi and Ohio rivers, but south of the Ohio river. For example, the low rates from Louisville, under the influence of the Chicago low rate, is felt in Memphis, Nashville, and further south. Freight from Memphis is shipped to Louisville and gets a low rate from there, and the people of Nashville and such places get as much advantage from the low rates as if really located on a water-course; so that the influence of the water transportation is felt almost throughout the whole country. That is the influence of the Erie canal. To the south there is the water route from New York to New Orleans *via* the ocean, and from New Orleans freight is carried to Memphis and Saint Louis and the West *via* the Mississippi. In order to meet these low rates, the east and west roads from Louisville and Memphis, or from Memphis to Norfolk east, have to conform again to the low rates made by the Atlantic ocean and the Mississippi river. In this way the water-courses are really regulating the railroad transportation rates throughout, one may say, the whole country. Rates generally are higher west of the Mississippi, but the peo-

ple west of the river get the benefit of the low rates east. In many other ways the water-routes help. The Ohio river, the Tennessee river, and the Cumberland river affect the railroad rates at the interior. There is plenty of competition that regulates the rates and keeps them at an exceedingly low figure. Not only do the water-ways control the rates,—narrowly limiting them, at any rate,—but the competition of the markets for the products that are to be carried is another great factor in fixing railroad transportation rates. The price of carrying grain, for example, is fixed not by the railroad companies, but in the markets of the world. That price is generally regulated now by the Liverpool market, and, if railroads want to carry any grain, they have to carry it at a price that will enable the producers to compete in the Liverpool market with the markets of the world. So widespread is the influence of competition that the charges for transportation in East India have even become factors in making railroad rates from Chicago to New York. There is no danger whatever of any excessive charge.

It can be shown that the transportation charges on almost every article of consumption are limited by commercial conditions. Many cheap articles, such as coal and iron and lumber, have to be transported at a very low rate, if they are to be transferred at all. The tariff is fixed by the market price of the products in the different sections of the country. The railroad transportation charges can never be more than the difference between the market values of the articles in different markets which determine for the railroad companies their charges in a great measure ; and therefore there is no necessity for any arbitrary legislation on the subject.

Some time ago I received a communication from a firm in New York, largely engaged in the stave and cooperage business, representing that it is making efforts to extend its business to Europe, and to place these products in the English markets in competition with those now brought to England from Norway. This firm applies to the railroad companies for lower transportation rates than are at present charged upon those articles when carried to New York for domestic consumption. The present rates to New York are perfectly satisfactory to them, and to the trade generally, as they ought to be, being but 6-10 of a cent per ton per mile,—not much more than the actual cash cost of the service,—but it is alleged that without further reduction it would be impossible to compete in the English market with the Norwegian products.

In order to encourage industry and commerce, and enable the people of America to enter into competition in foreign markets, the railroad companies might be perfectly willing to carry such freight des-

tined for export at still lower rates, or even at the net cost, without profit. They frequently do so to meet home competition in distant markets, or to aid in the development of the country. But it would be impossible for the railroad companies to carry the whole of their business at such low rates, or at the mere cash cost, leaving nothing for profit or interest on capital invested. Under the "Reagan Bill" the railroad companies are to charge as much for the export as for the domestic business,—for like service the same rates,—thereby prohibiting the railroads from giving to the commerce of this country that aid which otherwise they would be able to offer, and thus preventing the building up of new industries that might result to the great advantage of the people.

In my opinion, it is utterly impossible to formulate a law defining just and unjust discrimination. Any act is just in commercial transactions and in railroad management which does no injury and benefits all concerned. If it can be shown, as I believe it can, that nobody suffers from the fact that the railroads carry freight more cheaply over long than over short distances, the carriage of such freight is just and proper, and, being also beneficial to the commerce of the country, it should rather commend itself to the favorable judgment of legislators than be made a misdemeanor, punishable by fine.

Wherein does the injustice consist if the railroad companies carry freight intended for export to New York at lower rates than if intended for domestic consumption, as long as the charges for the latter are reasonable? It is certainly not unjust to the people in the West to create for them a market for their products. It certainly is not unjust to the merchants of this country who derive some profit from this trade. It certainly is not unjust to the American people that the English people should contribute to the wealth of this country by the purchase of these products. It certainly is not unjust to the railroad companies that they should increase their business, even at a small profit. It certainly is not unjust to the domestic consumer of the article in New York, who pays a higher price of transportation for it than the exporter; because, whether the railroad companies do or do not engage in the export business, the rates of transportation to the domestic consumer, reasonable as they are, remain unchanged. If the feelings of the domestic consumer are hurt because the exporter gets lower rates of transportion, he can console himself by the reflection that the foreign consumer has to pay the ocean freight in addition to the inland freight, making the total cost to him much higher than to the American consumer. To carry freight at a lower rate for the exporter than for the domestic consumer is, therefore, not unjust, since it is beneficial to all engaged in the transaction; *it* hurts no one; the

only disadvantage is to the foreign competitors,—in this case, the people of Norway. Is it the duty of congress to protect foreign nations against American competition?

Chicago is the regulator of the rates throughout the whole country, on account of its command of water transportation. The 'roads carrying freight from Chicago to the east have now an understanding, according to which each one agrees to be satisfied with a certain proportion of the total business from Chicago, and each one pledges itself not to pay rebates or secretly lower its rates in order to secure more than the proportion agreed upon. There is, of course, no objection to any one of the roads reducing its rates openly, if it chooses to do so, for then the other roads can make similar reductions; but it is agreed that these reductions, if any are to be made, shall not be made secretly, in order that one shipper or one railroad may not have an advantage over the other. An agreement of this nature has been incorrectly called "pooling." But you will observe that this agreement is made exactly for the purpose of carrying out the object of the Reagan bill, which is to prevent the payment of rebates, and thereby prevent unjust discrimination. The true nature and object of agreements of this kind are little understood; otherwise it is to be supposed that the prohibition of the only practical measure by which they can be realized would not have been made. This inconsistency is probably due to the misleading word "pooling," which, being a gambling term, has not the least application to the process to which it is applied.

It is a mistaken idea that these arrangements are compacts for the purpose of preventing competition, and it is upon this erroneous view that the objections are based. These agreements to divide the traffic between competing roads are changeable, according to the interest of the parties to the agreement. If one or the other railroad company improves its facilities of transportation, or improves its connections, and thinks it is entitled to carry a larger share of the traffic than it has been allowed in a division, it calls for a revision of the compact, and a readjustment must be made according to the merits of each line. In this way the spirit of competition is kept alive; each road continues to strive to secure the largest patronage; but, instead of doing so by paying rebates and by violating the laws of common carriers, it has to use open and legitimate means of competition.

The objections to the so-called "pooling" process are, therefore, based upon an entire misapprehension of its nature and of its good effects. It possesses the great advantage over absolute consolidation of railroad property—which is not considered illegal or against public policy—that it keeps up the spirit of competition, while at the

same time it secures the advantage of absolute consolidation,—unity of management. When private parties cannot agree on questions that may lead to dissension and quarrels, they are obliged to submit them to the adjudication of properly-constituted courts. They are not allowed to involve their neighbors in their quarrels; they are not permitted to set their own houses on fire to spite each other, and destroy the property of their innocent neighbors. And why should not the same restrictions of the law be applied to warring railroad companies, whose action and whose management involve such large public interests, and who are really the creatures and the servants of the public?

It is time that the antiquated notion that has taken such a strong hold of the legal minds of the country—the notion that all agreements between railroad companies, in regard to transportation tariffs, are against public policy, and are in the nature of conspiracies—should at last give way to a proper understanding of the true nature and objects of these agreements, and to a conviction of their necessity and of their highly beneficial results; and, instead of prohibiting such agreements, the government should give them legal force and should exercise its power in carrying them out. That is all that is required on the part of congress in order to settle this vexatious railroad problem.

REFORMS IN RAILROAD MANAGEMENT.

By Henry Clews.

THAT radical reforms are required in railroad management is a postulate that hardly anybody will controvert. If you should put the proposition in the form of a question to the various classes of reformers, from the president of a trunk-line system down to the political leader, Populist leader, free-silver leader, tariff-reformer, and Anarchist destructionist, all would answer "Yes" in the most emphatic tone. But from that affirmative point there would be an important divergence of opinion. Now, the problem in railroad management is to find a point of convergence at which these various opinions can be successfully focussed, with the exception of the views of the Anarchist. It is necessary to leave him out, if the others are to be retained.

These people are all elements of our body politic, and in a great question which affects the entire community they have a right to be consulted. Now, while it is impossible to satisfy all of them, and while majorities rule, it seems to me that a plan which would confer the greatest good on the greatest number should obtain a majority vote on a fair count. Railroads, if honestly and prudently managed, are capable of conferring the greatest possible commercial and social benefits upon the community and upon the human race, and they should therefore be managed in the interest of the whole people, but not by the government. This would at the very outset spoil the scheme of consulting all the diverse opinions to which I have referred. While parties are so clearly defined in our political system as Democrats and Republicans, there can be no safe government ownership of railroads in this country. In order that railroads may attain that degree of expansion and usefulness which is their inherent promise, they must be placed on a basis of stability, not liable to be shaken up every four years. Under government control there could be no well-laid schemes for the constant and uninterrupted development of the whole system and its progressive improvement. The quadrennial interruption of politics, and the numerous rivalries and jealousies inseparably connected therewith, would, in my opinion, play havoc with all the economic and industrial advantages—though they are many—capable of being derived from a grand central and bureaucratic system of government management. It may do well enough for Germany, where the military idea is predominant and the protective and defensive sys-

tem of the country may require it; but the people of this Republic would cut a sorry figure, I fear, in the leading-strings of paternalism, after the freedom with which they have become familiar, and government ownership of railroads here would play anarchism with Wall street securities. It would possess most of the bad features of the close corporation, and few of the good ones. It would at least be unwise to experiment with a government scheme until all hopes of reform in other directions had failed. Let that be the last resort.

Yet, if some plan is not put in operation to subserve the interests of shareholders, and protect them from the avaricious encroachments of managers, government aid may be called for as a forlorn hope; but I am still hopeful that means will be found of averting this calamity. I think a protective system of committees, chosen by the stockholders of every railroad, to investigate the management and have its accounts audited periodically by trustworthy experts, upon a plan that would exclude the possibility of collusion,—the reports of these committees to be submitted to a central association, also chosen by said stockholders, at reasonable intervals,—would reform, and, in time, thoroughly eradicate, most of the evils now complained of, and make the railroads the most potent instruments in developing our material prosperity, through our unlimited resources. There is a plan of this kind now in course of development, but not yet far enough advanced for a full description. It will, I believe, do more to solve the vexed problem of managerial integrity and capability than any of the previous devices, many of which have been very fair tentative schemes, but all of which have been lacking in breadth of purpose and general applicability of design.

The period succeeding the last panic has exposed more weak spots in railroad management, probably, than any former period. Matters seem to have been tending towards a culminating point during the past few years. The management has in too many instances been directed towards sustaining the market value of the securities, instead of building up the intrinsic value of the property. Borrowing money, at the expense of the property, to pay unearned dividends has played an important *rôle* in the operation of creating fictitious values, which have often acted like a boomerang and demoralized the speculative market. This system is entirely vicious, and will have no place in the reformed management proposed, by which the public in general will have ample means of discovering the true value of every railroad property. The veil of secrecy which has hitherto concealed so many rotten schemes, so fruitful of bankruptcies, defalcations, and panics, will be torn away, and the financial status of every property laid bare to public view and open inspection.

Of course, it will require some legislation to accomplish all this,

and it must be of a more comprehensive character, and more popular and beneficent in its outcome, than the Inter-State Commerce Law. The clause against pooling in that act must be repealed, and perhaps it may be necessary to recast the whole measure. I do not mean to disparage the legislators in whose brains the law originated, for I recognize the impossibility of foreseeing all the necessities that may arise in human concerns; but several years' bitter experience of the law in question has left no room for doubt of its inadequacy.

This law seems destined to cause endless trouble and expense wherever it comes in conflict with the State laws, and to this it is constantly liable. A case in point came up in the supreme court of the United States a few weeks ago from the Milam county court of Texas, reported in the *Railway Age;* it illustrates some of the great difficulties connected with making railway rates, and the perplexities with which freight agents have often to contend. The case, leaving out legal verbiage, was briefly as follows: The Gulf, Colorado and Santa Fé railroad was plaintiff in error against J. D. Hefley. A firm in St. Louis had shipped to Hefley and his partner, who were merchants in Cameron, furniture by the St. Louis & San Francisco railroad. The bill of lading showed that the freight charges were at the rate of 69 cents per 100 lbs., the whole bill being $82.80. Hefley presented the bill of lading, and made a tender of the money, which the railroad agent refused, not having been informed that the rate had been changed from 84 to 69 cents. He also refused to deliver the furniture. The agent was in this dilemma. If he refused to deliver the furniture on tender of freight charges, his company was liable for $82.80 for each day of delay, according to the law of Texas. If he did deliver it before the change in the rate had been posted up 3 days, the company would be liable to a fine of $5,000, according to the Inter-State law. So the agent prudently chose the less evil in refusing delivery. Hefley sued under the State law, and recovered his $82.80 for one day's delay; but the company appealed, and Judge Brewer reversed the decision of the court below on the ground that the State law, in a case of conflict, must yield to the national law as laid down in the constitution of the United States, which says in Article 6: "This constitution, and the laws of the United States which are made in pursuance thereof, shall be the supreme law of the land."

Now, here is a clear case, and a recent one, in which a railroad company has been enabled to take advantage of its own negligence, or the negligence of the company with which it connects, or both, to perpetrate a manifest injustice upon a merchant. If the notice of the change in freight rates had been posted up according to the requirements of the Inter-State law, of course the trouble would have been

avoided; but this only goes to show that a difficulty arising from the slightest omission in a simple detail of what this law requires, which a common-sense agent, without any education, legal or otherwise, could settle equitably in five minutes with any consignee of like common sense, may involve long and costly litigation to all parties. And it also shows that, even if the law were strictly conformed to in all its petty details, it still affords a large margin for vexatious and expensive delay, both to shippers and railroad companies. In the very case cited, the freight agent could not have acted, on pain of penalty to his company, unless the rate in question had been posted up 3 days, and, if an increased rate, 10 days. Everything relating to these notices was, of course, studied in advance by the most profound legislative minds, before the Inter-State law was enacted; but still the law will not stand the test in practice, when applied to the most ordinary transactions in shipping, which shows that the aftersight of the most illiterate shipper is better than the foresight of some of the most eminent legislators. This is humiliating for the legislator, but it is impossible to evade palpable and stubborn facts.

Secrecy seems to be largely at the bottom of bad management. If our national legislators, instead of attempting legislation designed to regulate rates and internal management, as exemplified in some of the abortive provisions of the Inter-State Commerce Act, would profit by the experience of Massachusetts, they would substitute for the Inter-State Commerce law, a general enactment requiring, under heavy penalties, the utmost publicity in official reports of railroad affairs.

The history of the Massachusetts Railroad Commission, which was first organized in 1869, shows what intelligent public opinion, properly directed, can do in reforming the abuses of corporations. It was at first an experiment on the part of Charles Francis Adams and a few other men of advanced thought and large experience. It was the means of bringing about reduction in rates in a very satisfactory manner to all interests concerned, and without very much friction. Its powers were gradually enlarged without becoming oppressive, and it has done more, perhaps, to solve the problem of so operating railroads as to meet the wants of the various industries and commercial interests of the State, while conserving the best interests of the stockholders and investors, than any other scheme that has been tried. The main object of the commission was, in brief, to discover how the roads could best be made to promote the interests of the State, and its history shows that great success has been achieved in this direction. The uniform system of auditing accounts, adopted by the commission, —a system to which all corporations were required to conform,—was one of its best features, and it was singularly successful in the intro-

duction of this system in adjoining States. In this respect it seems to have been the "little leaven" that may yet "leaven the whole lump." Let us hope so.

One railroad magnate, Mr. C. P. Huntington, thinks that consolidation is the remedy, carrying this idea so far, in fact, as to favor making all the railroads one great trust, or not more than three consolidations in all at the very outside; he believes that one would be best. Such a trust as he imagines would undoubtedly greatly cheapen the cost to both producers and consumers, as he argues; but it would require ironclad legislation, strictly administered, to regulate a trust of such unprecedented magnitude and potency as Mr. Huntington approves. It would be nationalizing the management of the railroads, after all, but in a slightly roundabout fashion. "Of two evils choose the less" is a good and durable, though trite, adage; but which of the evils would be the greater in this case is, I think, problematic,—a big trust that would conduct the carrying-trade of the nation, or a government that would do the same thing. I think it would be bad policy to risk either at the present stage of our social development.

It seems evident to me that either this plan of Mr. Huntington's or government ownership would destroy competition; this would be against public policy, and would eventually destroy healthy speculation and investment, first bringing these operations to a general condition of stagnation. All other business, in my opinion, would suffer in sympathy, and we should recede to a state of inactive, semi-Oriental barbarism.

Consolidation on a large scale, destroying competition, would deprive railroad management of that pride of emulation for which there would remain no motive, and which is one of the most potent causes of the great efficiency of the roads as carriers, and of their progress towards a still higher standard of efficiency. A government of, for, and by the stockholders, having their protective committees duly elected and organized to carry out their wishes and to report all delinquencies on the part of officials, as well as deficiencies in management, and all loose and negligent methods inconsistent with the best interests of the security-holders, seems to me to be the panacea, if there is any, for the railroad troubles. Under a system administered in this way, we should not have that unhappy state of things which Dr. Chauncey M. Depew post-prandially deplores,—namely, "when railway officers and employees are separated from their fellow-citizens of other pursuits, and relegated to the unhappy position of doubtful persons in a community." It is greatly to be regretted that the country should have to suffer the loss of Mr. Depew's failure to reach the executive chair in the White House, simply on account of

those business connections for which he is by no means to blame, and over which he has had hitherto hardly any more control than he had over the circumstance of having been born in Peekskill. But there are some unfinished suggestions in that Detroit speech recently delivered. Take the following specimen, for instance: "The railroad is an expression of commerce, and the iron rails interlacing and intertwining through the States are bonds of union. . . . This internal commerce of the United States makes our country the most wonderful market this globe has ever known. It is the breath of our national life. With it in prosperous condition, we can successfully compete in the markets of the world." It strikes me forcibly, then, that it is of the first importance that this "breath of our national life" should not be stifled by any methods of suffocation such as those employed by railroad managers who organize stock-jobbing schemes in their own securities and become railroad wreckers. These throttlers should themselves be asphyxiated, and General Depew is one of the heroes best qualified to lead a successful charge against these enemies of our national life and prosperity.

It is clear to me, after looking over the railroad situation, especially with regard to the intrinsic value of railroad securities, that, if our great railroad system is to escape the petrifying enslavement of national ownership on the one hand, and the evils of consolidated monopoly on the other, the most effective means of assuring this escape is so to administer the operations of the roads that their securities will command the confidence of the greatest possible number of investors, both large and small. The panic of 1893 afforded a stupendous object-lesson as to what is pretty certain to happen when investors begin to lose confidence. While business is prosperous, the weak places in railroad properties are hidden from public sight, often in the glare of speculative success. This is the case now, to some extent. But, when trouble assails, failures begin, and money becomes stringent, then the weak spots become rotten and the bad and fraudulent management is exposed, the consequences being panic and disaster. What happened in this country to railroad properties in 1893 is happening daily all over the world to business men who foolishly betray the confidence reposed in them by partners, stockholders, and bankers, and the fact is patent to any one who will look over the list of stock-exchange securities and compare the present with the past that the properties which weathered the panic of 1893 were, with few exceptions, those that have been characterized by sterling honesty and the utmost publicity in their managment. The history of those that got into trouble has been partly written, but the most interesting chapter has yet to be brought to light. It will furnish a startling con-

trast to the history of the prosperous securities, but the time may not yet be ripe for a full exposé.

We have at present among our railroads some eminent illustrations which demonstrate that properties honestly and capably managed have steadily risen in value. Among these may be named the Vanderbilt systems, the Pennsylvania system, the Rock Island, Illinois Central, Delaware and Lackawanna, Delaware and Hudson Canal, some of the Grangers, and a few others. I could name a number in the opposite category, but do not wish to make invidious distinctions. Some of the latter are likely to fall in line with the new era of reform, and may largely retrieve past delinquencies.

It is amazing to contemplate the great prosperity that our railroads are capable of conferring upon the country under efficient and honest management. In spite of all the mismanagement, our freight rates are only about one-third of the lowest average known elsewhere in the world. Our average rates, according to Mr. Depew, are only 8 mills per ton per mile. Those of Great Britain are 2 cents and 8 mills, or three and a half times as much as ours; those of Russia, 2 cents and 4 mills; of Italy, 2 cents and 5 mills; of France, 2 cents and 2 mills; and of Germany, where the government owns the railroads, 2 cents and 4 mills, or exactly three times the rate of our roads.

The rates given by the Inter-State Commission differ slightly from Mr. Depew's figures. They are as follows: in Great Britain, 2.80 cents; in France, 2.20 cents; in Germany, 1.64 cents; in the United States, .878 cents in 1893, and .866 cents in 1894.

This difference, however, is not very material for the purpose in view. The comparison, however, demonstrates the wonderful results which the immense magnitude of our railroad system—about twice the length of the aggregate systems of the world—and our geographical position have enabled us to attain. Its predominating advantages to our commerce are incalculable. Let us, then, make the best use of these advantages by more efficient management, and thus gain a higher preëminence among the nations of the world. Let our railroad system be so developed and expanded in the future that all the people may be made partakers in a still greater degree of the national prosperity which it is capable of conferring upon us; and, while the wealth of the family of Crœsus shall be accorded all that the law and fair dealing allow in the field of investment, let it be in all respects subordinate to the general interest and welfare of the republic, and that without any paternalism, Socialism, Populism, or Anarchism.

WILL TRUNK LINES BE OPERATED BY ELECTRICITY?

By Frank J. Sprague.

WILL trunk lines be operated by electricity? This is a question which is naturally asked, whether by the engineer who, with a knowledge of what has already been accomplished in the face of many difficulties, seeks to determine the ultimate development of a great industry, or by the layman who, with a casual knowledge of the advances of the past few years in the various departments of electricity, but with no technical knowledge, easily conceives an imaginative future of vast possibilities.

Every one, however, who has been at all identified with the growth of any industrial development, or who is familiar with the difficulties encountered and surmounted, knows that sentiment has not determined the present status of, or materially aided in, any great electric development, whether it be in the field of the telegraph, the telephone, the electric light, the electric railway, or the electric elevator.

Each of these has won its present position in the commercial world in the face of great opposition, and only after having demonstrated its utility in facilitating intercourse and communication or in conferring great benefits upon mankind, while at the same time achieving economies in life and a substantial income upon investments.

This is true with every industrial development, whether it be in the department of electricity or not; and it may be safely stated that in this particular science there will not be material advances except such as accomplish manifest economies and show a commensurate return. One hears many prophecies as to the future of the electric railway. It has been said that the epitaph of the locomotive has been written,—that the trunk-line road awaits early transformation. The ordinary laws of the transmission of energy, the restrictions of earning capacity, the ratio of investment to return, established lines of intercourse and habitation, geographical outlines, climatic conditions, and the existing limitations of terminal facilities are set at naught by the over-enthusiastic prophet with a happy *nonchalance* ordinarily unproductive and misleading.

It is perhaps unfortunate for these exuberant individuals that the financial question is so serious a factor in determining the growth and the limitations of any industry, but nevertheless it is a fact which cannot be ignored. So in all soberness let us consider briefly, then, what has been done in the electric railway, and what are its possibilities.

Seven years ago there were in existence as many electric railways of all kinds and characters, experimental or commercial, as could be counted upon one's hands. Scarcely any two were alike. None represented the system of to-day. None could be counted other than of a tentative character.

The birth of the present trolley system may be fairly put down as at Richmond, Va., which line was opened in February of 1888 by the Sprague Electric Railway & Motor Co., and of which there appeared in the ENGINEERING MAGAZINE of September, 1894, some personal reminiscences by the writer.

Since then there have been put into operation in the United States, England, France, Germany, and Italy, not less than seven hundred electric railways, covering not less than 7000 miles. There has been invested in the electric railway industry fully $250,000,000, and there are to-day connected with it fully one hundred thousand people. The once laughed-at and despised trolley, now alternately praised and condemned, has become a most potent factor of our busy life and civilization.

It is true that it has oftentimes disfigured streets, but, while it has occupied the air, it has been instrumental in forcing other wires under ground. It has given us better-paved streets, greater cleanliness, more perfect tracks, and luxurious, well-lighted, and well-ventilated cars; and with the higher speeds it has made possible the extension of the taxable and habitable areas of towns in a much greater ratio than is represented by the increase of speed. It has released from the most cruel drudgery tens of thousands of animals; it has given employment to an army of men; it has improved the telephone service by forcing the abandonment of the ground circuit and the adoption of the metallic circuit; it has shortened the time of transit between our home and business; it has bettered the *morale* of employees, who, instead of urging on jaded beasts, have become the operators of an unfeeling, but tractable, machine; it has built up unoccupied territory; and it has given employment to idle capital. It has even built up homes, though it has devastated some; and though it has oftentimes been a juggernaut, the fault has not been entirely its own.

In short, the trolley system is perhaps the most remarkable example of an industrial development that the world has ever seen, and yet when, impressed by the greatness of this industry and made familiar with the changes which it has wrought in so short a space of time, one asks: "Will the electric motor replace the steam locomotive? Will trunk lines, as such, be operated electrically? Is the field of the electric motor universal, or is it special." We must answer as we would to the questions: "Will the telephone replace the telegraph, or the electric

light the manufacture of gas?" And the answer is: It is not exclusive, its reign will not be universal. In fact, all industrial developments on great and extended lines which have proven and are present boons to humanity, and make effective use of natural laws, must each and every one, and not one to the exclusion of all others, be utilized in our complex system of life.

The electric railway, even in the field it already occupies, has not accomplished everything, or by any means solved all the problems of transportation; and, when we consider its application to existing railways, and look forward to see what the probabilities are of a wholesale and exclusive utilization of electricity for transportation purposes, we must consider what it has not done, and at the same time see why the advances already made have been so phenomenal.

There are many reasons. First of all, there exists the universal necessity of transit, whether it be urban, suburban, or trunk-line. Travel is our natural law, whether from house to office, from town to city, or from coast to coast, and every available means which will facilitate traffic, whether by animal or mechanical power, will naturally be used.

In the great street systems which have spread all over the country the motive power in the past was principally animal. It was the most natural, but at the same time one of the most expensive, and in many respects an unsatisfactory, service. Where heavy duty was required, it was most deficient, so that the cable came in time to be recognized as a preferable mode of locomotion under certain restrictions,—in other words, the application of steam power instead of animal power, wherever the investment and the amount of traffic warranted it.

When, therefore, it had been demonstrated that electricity, whatsoever its nature, could be utilized as an active agent for the transmission of energy from a central station to reasonable distances covering existing lines ordinarily operated as tram systems; when it was found that there would be a saving in the cost per ton moved, that increased speed could be attained, that more people could be carried, and that greater areas and distances could be covered,—what more natural than that the trolley should take the place of the horse?

Branching out from these systems, there naturally came more ambitious lines, not perhaps so much in the total duty done or in the weights carried, but rather in the distances run, the speed attained, and, in a small degree, the electrical pressure used.

On suburban lines the speed was naturally increased because the street-traffic conditions were less limiting. These lines have often paralleled existing steam lines, whose traffic they have somewhat seriously interfered with, but they have, in addition, created a traffic of their own. They have generally followed existing highways, and have

had the advantage over the steam road, not in the actual speed maintained, but in the fact that, with lighter roadbeds and as single units running at short intervals and at a good speed, they have more efficiently served a number of people.

Frequent cars, stopping wherever required to take up or deliver passengers, and with a minimum fixed rate of fare, naturally can give a better service, even with a reduced rate of speed, than more infrequent and larger steam trains stopping only at predetermined stations.

All this has made it possible for the electric railway to create a traffic of its own as well as take away a portion of the traffic of the steam railways. This sort of development will go on, until the trolley system is almost as common as the turnpike. It will establish lines of communication which have not hitherto existed; it will build up new territory; it will act as a feeder to great trunk-line systems, both for passenger and certain classes of freight work; and it will largely encroach upon special fields now occupied by the trunk lines.

But, when we depart from this class of service and take up what is essentially a trunk-line system, there are many questions to be considered,—and not alone those of the local and express service, but also a most important one, which is rarely considered when electric railways are talked of; I refer to the trunk-line freight service,—that is, the transportation of goods in great bulk over long distances. One must remember that trunk lines, as they now exist, have been built up by a slow process, and that no very serious change from their existing conditions can be made, considered from the commercial standpoint, except after grave deliberation and at very great expense. Unless passengers and goods can be moved over a system with increased benefit to a community, or at a reduced cost, or with a commensurate return on capital invested, an electric will not replace a steam system. Of course, in these remarks I ignore specific problems, such as the utilization of a storage battery and motor in place of a locomotive, or of a moving central station, as is being tried on one of the French lines, or those special problems like the Baltimore tunnel, in which an electric locomotive will be utilized for a short distance in place of the steam locomotive; I am considering the possibilities of what is generally considered an electric system,—that is, the operation of a number of train units from a central station.

If we were to refer for a moment to any other system of transmission of power,—for example, by water or air,—no one for a moment would question its limitations. We all know that any amount of power can be so transmitted, but only with definite losses which depend upon the pressures used, the sizes of pipes, and the distances and amount of energy transmitted. So it is in the transmission of

electricity, which is nothing more or less than an agent whose exact character we do not know, but whose obedience to certain empirical laws is absolute.

It is unnecessary here to repeat the specific laws covering such transmission; they are perfectly well known, and there is no practical hope of their being changed, any more than the laws of gravity. Recognizing these laws, there is a distinct limitation to the distance and amount of power which can be economically and conveniently transmitted and distributed, no matter how perfect the generating or receiving machinery may be; and these two particular elements have been brought very nearly to their maximum possible efficiency.

It may be said—which is perfectly true—that, if from a central station one can conveniently operate a number of distributed units over a 20-mile road, why cannot two, or, for that matter, a dozen such systems be connected together? So they can, but this does not form a trunk-line system. Of course, if we consider the steam trunk line from a passenger standpoint, the present system has defects, and the principal one is the inconvenience of service when considering short distances. If one is going a long distance, then it matters not so much whether trains are two or three hours apart in leaving; but long-distance travel and short-distance travel have not the same requirements so far as the passengers are concerned.

If nothing is sacrificed, it would be preferable, of course, to have smaller units despatched at more frequent intervals, no matter what the distance of travel. But, as I say, this is less important when dealing with long distances than when dealing with short ones. When trains are operated in large units, with comparatively few units between terminal points, and these at considerable intervals, the steam locomotive will absolutely hold its own. When, however, these larger units are broken up, the intervals of train-despatching can be shortened as much as is consistent with satisfactory operation, and the number of units distributed over a line made correspondingly large; then, and then only, will electricity be used on suburban lines and lines connecting important cities.

I have again and again advanced the substance of this statement, and I must here repeat and emphasize this fact,—that, so far as passenger service is concerned, considering for the moment only economy of operation, the problem narrows itself down to the number of train units operated between terminal points. Make that number sufficiently large, and the electric motor is the best means of propulsion, whether for high or low speed. Decrease this number, and you must rely upon steam.

Or, putting it another way, the answer to the query, will elec-

tricity take the place of the steam locomotive for railway service, is: only in part, and then only when the number of units operated between terminal points is so large that the resulting economy will pay a reasonable interest on the combined cost of a central-station system of conductors and the motor equipment, and the traffic existing is commensurate with the needs of such a system.

It is perfectly true that, looking only at the time standpoint of passenger traffic, it is entirely possible and feasible even, not only to operate any existing street or elevated system, and many of the suburban systems, but also the traffic between such points as New York and Philadelphia, on a subdivided electric service; but this is not all that is required. The more frequent the units despatched over the track, the more exclusive must be that particular track for that particular service, and the larger must be the number of tracks to take care of all the varied service of a great system.

Briefly, the service may be characterized as the transmission of passengers from one local point to another and the transmission at high speed between principal points,—that is, way and express service,—and the handling of freight in great masses with all the attendant switching and distribution at way and terminal points. Considering only the transit needs of these various services, a six-track railroad might be considered desirable, and probably would be; but there are many problems connected with such a road, to say nothing of the fact that it would often be impossible to construct such a system on existing rights of way. Independent of the matter of investment, rights of way, or construction, the problems of switching, passenger landings, and freight acceptance and delivery, on a six-track railroad would be a grave one.

Freight cannot be handled like live loads. A succession of cars each with twenty or thirty passengers might well take care of all the passenger traffic on a road, but freight cannot ordinarily be handled in any such way, except by an enormous increase of expenditure. The 30-, 40-, or 50-car train, pulled by a single locomotive with a limited train crew, presents an economical transportation of freight which no system of units on long-distance transportation can hope to equal.

It may be contended that there is a way to create a six-track service, and that it can be operated partly electrically and partly by steam, and that the small units for way service can be run on one set of tracks, the express units on another, both subdivided, and that larger freight units at long intervals can be operated on the third. But this proposition will not appeal with any practical force to a railroad man, or to the electrical engineer as such, because it is absolutely vital for successful electrical operation from a central station that the units shall be di-

vided, and that there shall be a distributed service, and not a localization of large units at long intervals at any portion of the system.

It seems hardly necessary to even refer to the question of signals, and all the difficulties which would exist if an attempt were made to operate a road simultaneously with electricity and steam. Human life and its absolute dependence on these signals, which neither natural laws, stress of accident, or the conditions of weather should interfere with, make this of vital importance in considering any change.

One of the great advantages of the electric system, as generally used, considered from a traction standpoint, is the fact that the motors are carried under each individual car, or, with few exceptions, under one of two or three cars, thus giving the advantages of a high proportion of weight for traction, with the consequent distribution instead of localization of weights. When motors reach their highest standard, every car can be made an individual unit, which can be operated in any combination and from any point of a train, but this advantage instantly disappears when it is attempted to use an electric locomotive after the manner of a steam locomotive,—that is, to put it ahead of a number of car units whose aggregate weight may be from five to twenty-five times its own. It must, then, in a large measure be limited by identically the same laws in the matter of weight and traction as the present steam system. Assuming units which are common on steam roads, such as 1000 or 1500 h. p., the enormous loss of energy and the variation of pressure on a line would make the cost with any possible allowable loss entirely impracticable.

Let us lay aside, then, some of the visionary prophesies concerning electric railways. Perhaps no one has been more actively identified with them than myself; no one, I think, has greater faith in the future of the electric railway than I; but its future is not in the wholesale destruction of existing great systems. It is in the development of a field of its own, with recognized limitations, but of vast possibilities. It will fill that field to the practical exclusion of all other methods of transmitting energy; it will replace the locomotive on many suburban and branch lines; it will operate almost all street-railway systems and elevated and underground roads; it will prove a valuable auxiliary to trunk systems; but it has not sounded the death-knell of the locomotive any more than the dynamo has sounded that of the stationary steam engine. Each has its own legitimate field, which will play its proper part in the needs of all civilization.

BY
BRADFORD L. GILBERT.

IT is scarcely more than half a century since the architecture of railroad stations became a necessity or even a possibility. As the railroad station is the one architectural object which Americans see everywhere and with the greatest frequency, and the one in which many thousands daily have nothing better to do for hours than await the departure of their trains, there is to-day no other field of architecture which offers such wide opportunity for the most potent and elevating

ST. PANCRAS STATION, TRAIN SHEDS AND TERMINAL HOTEL, LONDON.

architectural education. Until a comparatively recent date, however, cheapness alone was the principal consideration in the erection of stations in this country, placing them in strong contrast to such buildings abroad, where, with the exception of the churches and some pub-

LA GARE SAINT LAZARE, WITH TERMINAL HOTEL, PARIS.

lic buildings, the railroad stations seem best to illustrate the typical architecture of each country.

The following illustrations have been selected to demonstrate this fact, and they form part of a personal collection gathered upon a recent extended foreign tour, made for the purpose of studying railroad-station problems.

The photographs speak for themselves, requiring only general explanation.

The buildings, upon personal inspection, indicate careful study and adaptation to the site and all requirements.

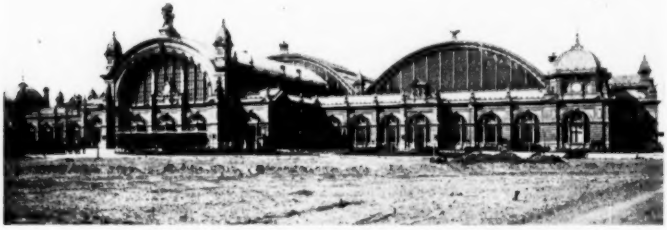
The St. Pancras terminus is possibly, with one exception, the best

FRIEDRICHSTRASSE STATION, SHOWING STORES UNDER VIADUCT.

known of the station buildings in London, considered from an architectural standpoint.

On the continent, however, with few exceptions, the general exterior design of the principal stations can usually be recognized as the work of an architect, and the effect is certainly a vast improvement over the treatment of the problem from an engineering standpoint only.

Even were it possible to cover all the tracks within the Paris station train-shed with one (or even two) single-span arches, as is so frequently the case elsewhere, and as shown at Friedrichstrasse, the proportion still would be far better with the use of intermediate supports,



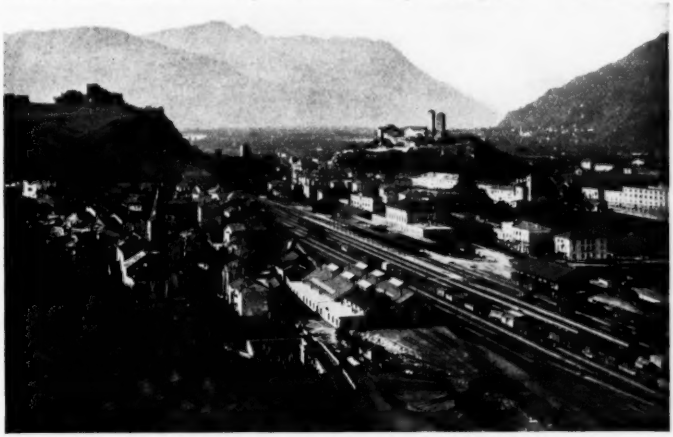
PHOTOGRAPH SHOWING PRINCIPAL FAÇADE OF UNION STATION, FRANKFORT ON THE MAIN.

the expense certainly less, and the practical service equally good. In the photograph of the Terminal Hotel connected with the Paris station the café in which the recent bomb explosion took place is plainly seen. The revenue from rental derived from the otherwise useless space under the viaducts of the Metropolitan Railway of Berlin, including Friedrichstrasse as shown, should appeal to the practical, if not the artistic, sense of railroad officials generally.

It is seldom the case that a large terminus is planned with enough foresight, or, more correctly speaking, with enough realization of

INTERIOR OF GENERAL BOOKING OFFICES AND CENTRAL HALL, UNION STATION, FRANKFORT ON THE MAIN.

actual future growth, to provide for later developments and actual traffic requirements, without considerable additional expense, and in a great measure destroying the unity and harmony of the original design. The formation of railroad terminal companies in so many of the large cities, to divide the vast expenditure required for enlarged ground space (actually made valuable in the first instance by the location of the railroad terminus), tells its own story. In a recent conversation with Col. Walter Katte, chief engineer of the New York Central, on this question, the importance of this was very clearly demonstrated by the extensive and expensive improvements now in progress in connection with the passenger traffic to and from the Grand Central Station, New York, which 25 years ago was believed equal to all future demands, and to day is found totally inadequate. The same is



BELINZONA.—SHOWING USUAL TYPE OF LOCAL PASSENGER STATION.

true of the passenger stations at Philadelphia, Chicago, St. Louis, San Francisco, and other principal cities, where the companies have been rudely awakened to the truth, and in several cases have made provision accordingly.

As at Frankfort, it would in many instances undoubtedly prove a paying investment to purchase land just outside the city limits, construct new boulevards, and erect such railroad buildings as seem desirable for present needs and future development. The increased valuation and sale of the land would cover the first cost with a handsome profit for revenue.

In the majority of instances first impressions are the more enduring, particularly of buildings and places. Pleasant environments, tastefully-

PRINCIPAL FAÇADE OF STATION AND OFFICES, AMSTERDAM.

RAILROAD STATION, TRAIN SHED AND OFFICES, ZURICH.

RAILROAD STATION ON THE GRAND CANAL, VENICE.

STATION, OFFICES, TRAIN SHED AND OPEN SQUARE, MILAN.

decorated grounds, the proximity of a public square, each help to set off the station to best advantage. The writer recalls several places where the open squares, temporarily loaned to the city by the railroad company have been partially utilized later at small expense for increased traffic accommodations, at great advantage to both the company and the public.

At Milan the large public square, just outside the city gates, gives an air of dignity to the station which it otherwise would not possess.

The reflection of the station at Amsterdam, with its towers and projections, in the placid river below, lends a quaintness and picturesqueness to the whole structure.

The station at Zurich, a city of a little over one hundred thousand inhabitants, will compare favorably with the stations in any of our own cities of equal size.

If the proverbial hackmen are missing at Venice, the noisy gondoliers fill their places with credit to themselves. The station is in

STATION AND TRAIN SHEDS AT BRUXELLES.

RAILROAD STATION AND OFFICES, DUBLIN.

keeping with the many handsome buildings surrounding it, belonging to the Renaissance.

The stations erected for the smaller villages and towns on the continent, all bear a strong family likeness, not at all unlike our own "class stations"; but frequently the picturesque surroundings add a beauty and charm shown in the views of Vitznau and Lake Leman,—the latter a particularly interesting and beautiful view.

RAILROAD STATION, VIADUCT AND TRAIN SHED, COLOGNE.

The growing public demand for railroad stations which afford comfort and convenience, as well as architectural beauty, deserves the attention it is receiving from railroad officials generally.

The widespread territory covered multiplies the opportunity for the use of varied building material and designs, meeting climatic influences and local conditions to an extent beyond all known precedent.

Architecture should so far become a delineator as to indicate upon its face the character of the work it is intended to portray.

A good design, graceful contour, correct constructional outlines, and symmetrical proportion, carried out in permanent material, necessarily combine to form the elements of all successful architectural work.

Architectural beauty alone in buildings cannot be said to have any

PRINCIPAL STATION, OFFICES AND TRAIN SHED, ROME.

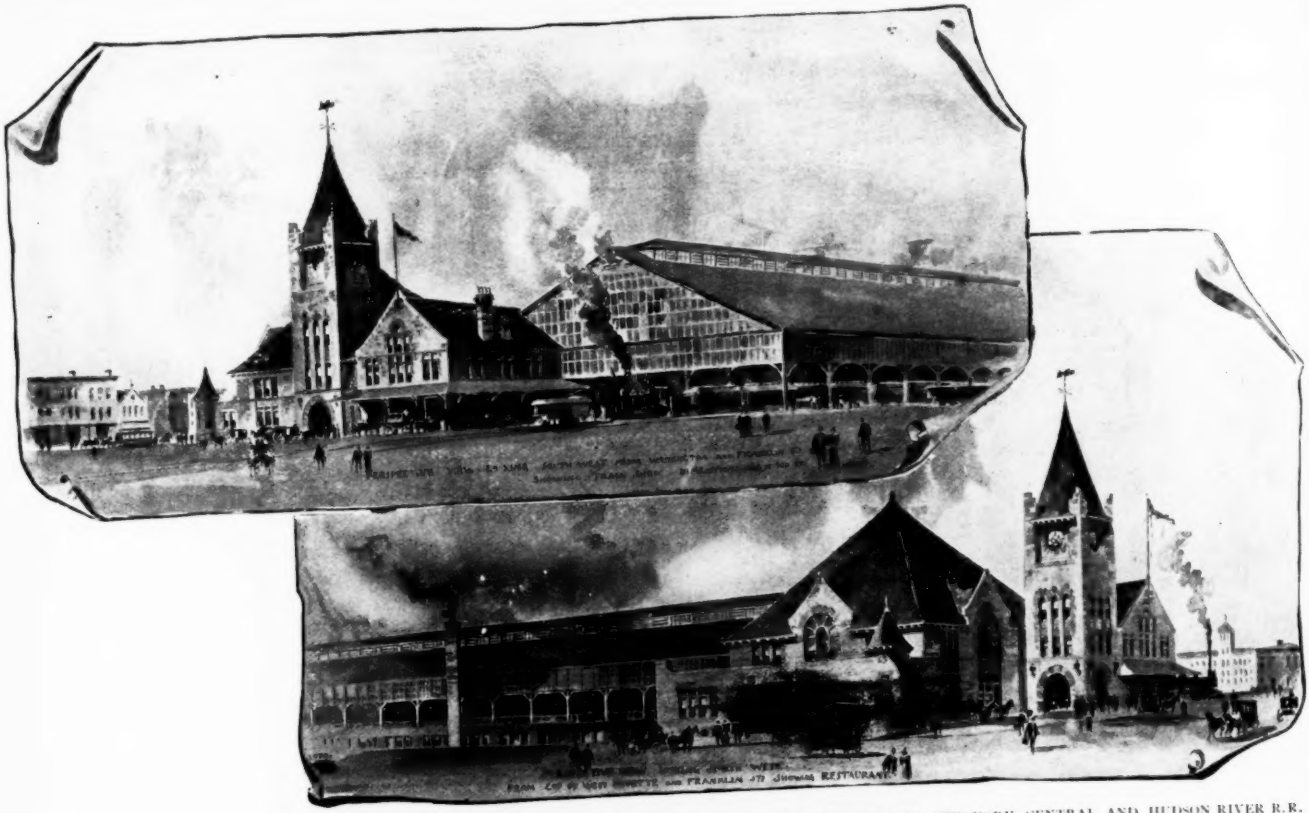
justifiable existence. It should be made secondary to both construction and utility. These should become the fundamental and underlying principles of all correct design.

Considering the general character of the buildings, probably no other distinctive style is capable of such freedom of treatment, or such variety of detail, in connection with station buildings, as what might be termed "modernized Romanesque"—an architectural treatment used so effectively by the late Mr. H. H. Richardson in almost the first of the station buildings to attract special notice in the vicinity of Boston.

It may not be generally known that the "Romanesque" has held its own among all other types for a longer consecutive period of the world's history than any other distinctive style of architecture, not excepting the Renaissance which immediately followed. Possibly in

LAKE LÉMAN: SHOWING THE PREVAILING TYPE OF SMALL STATIONS; THE CHATEAU OF CHILLON IN THE DISTANCE.

STATION WITH AGENT'S ROOMS, VITZNAU; SHOWING USUAL TYPE OF PICTURESQUE SWISS STATION.



STONE PASSENGER STATION, WITH LOCAL OFFICES, RESTAURANT AND TRAIN SHED, SYRACUSE, N. Y., ON THE NEW-YORK CENTRAL AND HUDSON RIVER R.R.

time we shall evolve from all the prevalent styles what shall prove a broad, natural, and truly national type of American architecture, based upon the best and most appropriate features of all the various orders; and what more suitable beginning can offer than the railroad station problem?

The American illustrations have been selected by the editor of this magazine from a collection of original black and white drawings and photographs, specially prepared to demonstrate the evolution in railroad station architecture during the last quarter century. These were personally loaned for hanging in the Exhibition Building erected for the New York Central Railroad Company at the recent World's Columbian Exposition, Chicago, and called forth much favorable comment both from American and from European railroad officials.

As examples of a portion of the railroad work personally carried out, it is believed they will possess a certain weight in verifying personal statements and suggestions on the subject of railroad-station architecture.

The Syracuse station as shown, on the New York Central Railroad, is constructed of granite with red sandstone trimmings, and is designed with a Romanesque motif throughout. The rotunda is 90′ 6″ square, and out of this open all of the principal rooms. Below is a large restaurant and lunch room, reached either directly from the street, or through a generous, well-lighted subway below the tracks. Local offices are arranged in the second and third stories, while a large train-shed covers all of the principal tracks and platforms.

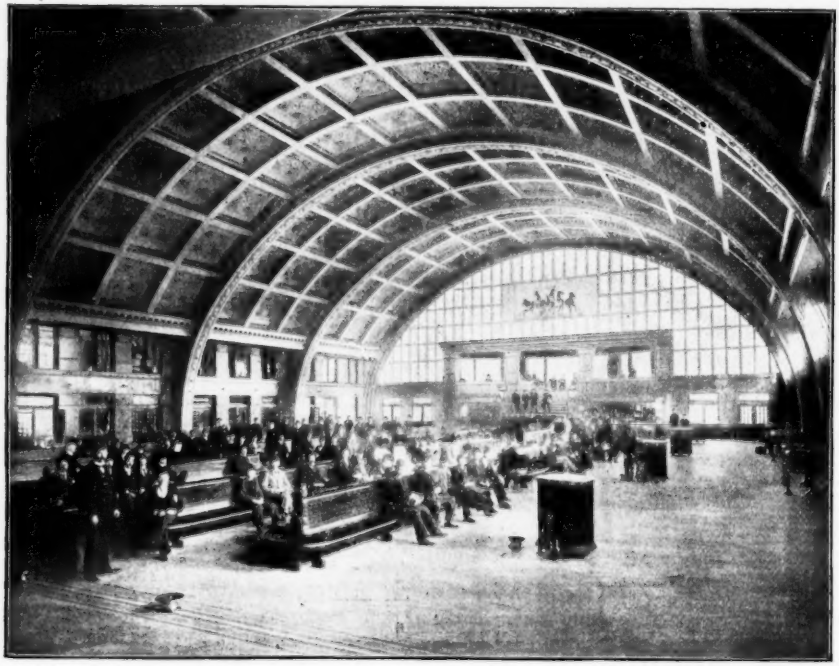
The Illinois Central Railroad general offices and union station at Chicago was necessarily designed to meet the peculiarities of the site and actual traffic needs. It was opened to the public 10 months after beginning work, to accommodate the World's Fair traffic, and at a total outlay of about $1,800,000. The foundations necessarily formed one of the principal items of expense.

While the Illinois Central station might be called a terminal station, eight through tracks pass under the rotunda. Passengers are transferred to and from the platforms of the train-shed on overhead passages enclosed, or underneath by well-lighted, thoroughly dry subways.

From actual measurements, the floor space of the principal waiting-room or rotunda, as shown, is larger than the one given of Frankfort, which is said to be the largest on the continent.

The marble wainscoting carried to a height of about 14 ft., and the marble mosaic flooring, together with the fire-proof construction of the building, are intended to render it permanent. Separate waiting-rooms, smoking-room, barber's shop, large restaurant accommodations, etc., are shown on the photograph of the interior.

ILLINOIS CENTRAL STATION AND GENERAL OFFICES, CHICAGO.



Interior of General Waiting Room or Rotunda, (located over tracks) 150 ft. by 100 ft. Restaurant, Smoking Room, Women's Room, Barber Shop and all accessories connected.

The Mexican National station, with general offices and railroad hotel, was designed to meet these requirements and the climatic conditions of Mexico. A somewhat different plan, however, was adopted for the station now in course of erection at Colonia.

The station at Lowell, Mass., was located by the Boston and Maine Railroad Company upon a triangular plot of ground, with tracks on two sides and one of the principal streets across the end, while another crosses overhead above the passenger platform at the opposite end (as shown on the photograph), and is reached directly by a stairway.

RAILROAD STATION, GENERAL OFFICES AND TERMINAL HOTEL, DESIGNED FOR THE MEXICAN NATIONAL RAILROAD CO., MEXICO.

The station at Fall River, Mass., was erected for the Old Colony Railroad, before its consolidation with the New York, New Haven and Hartford Railroad system. It is intended to meet the needs of a wealthy community of upwards of seventy-four thousand persons. Milford pink granite, with trimmings, quoins, and voussoirs of Long Meadow sandstone, form the exterior, the detail treatment of which is shown on the photograph. The interior is finished in oak and hard pine throughout.

The union station designed to be erected at Manchester, N. H., contains various waiting-rooms and local offices, with large train-shed connected for the traffic of this large manufacturing city.

The station at Liberty on the New York, Ontario & Western Railroad is of frame construction, the outside being covered with shingles creosoted, while the roof is of slate. A wide passenger platform, extending in both directions from the building, and with seats framed between the supporting posts, connects the end baggage-rooms. The station is located on a curve, as well as on a considerable incline.

The Middletown, N. Y., station is of brick construction, containing large restaurant accommodations and local railroad offices.

The stations at Bridgewater, and Ashmont, Massachusetts, are constructed of granite for the exterior and of hardwood for the interior finish, with all known conveniences.

The small station at New Boston, Mass., is built of field stone, the gables roughly stuccoed in cement and pebble dash.

Essex Fells is a small but growing suburb of New York. The station is partly built of stone, with frame construction. The porte-cochère is located at one end. Above are rooms for the station agent. Built at a cost of under $3000, exclusive of platforms, this is a specimen of what can be accomplished at a small outlay.

The station at North Branch, N. J., is built of local brownstone with slate above, an example of a low-priced station, containing all modern improvements, including steam heat.

The station at Toluca, Mexico, is built of native stone, the greater portion of which was carried on the backs of peons and burros for many miles. It is designed to meet the three-class conditions of the country.

The station at Laconia, N. H., is built of granite. The central feature is the rotunda, from which all the other rooms open. This is lighted during the day by clere story windows above the roofs of the porte-cochère and wide passenger platforms.

A layman is apt to judge of the success and value of a railroad by outward evidences of its wealth or taste and provision for public comfort. Railroad officials generally,—not excepting the chief engineer,—partly on account of their professional business training, principally on account of the high pressure under which they are constantly driven and the important business requiring their immediate attention, seldom have time to consider the artistic and architectural elements required to make their stations the success in these respects which they might readily become without any additional expense, and frequently at an actual saving in cost, if intrusted to any competent architect.

GRANITE SUBURBAN STATION AT ASHMONT, MASS., ON SIDE HILL, ERECTED FOR THE NEW YORK, NEW HAVEN AND HARTFORD R. R.

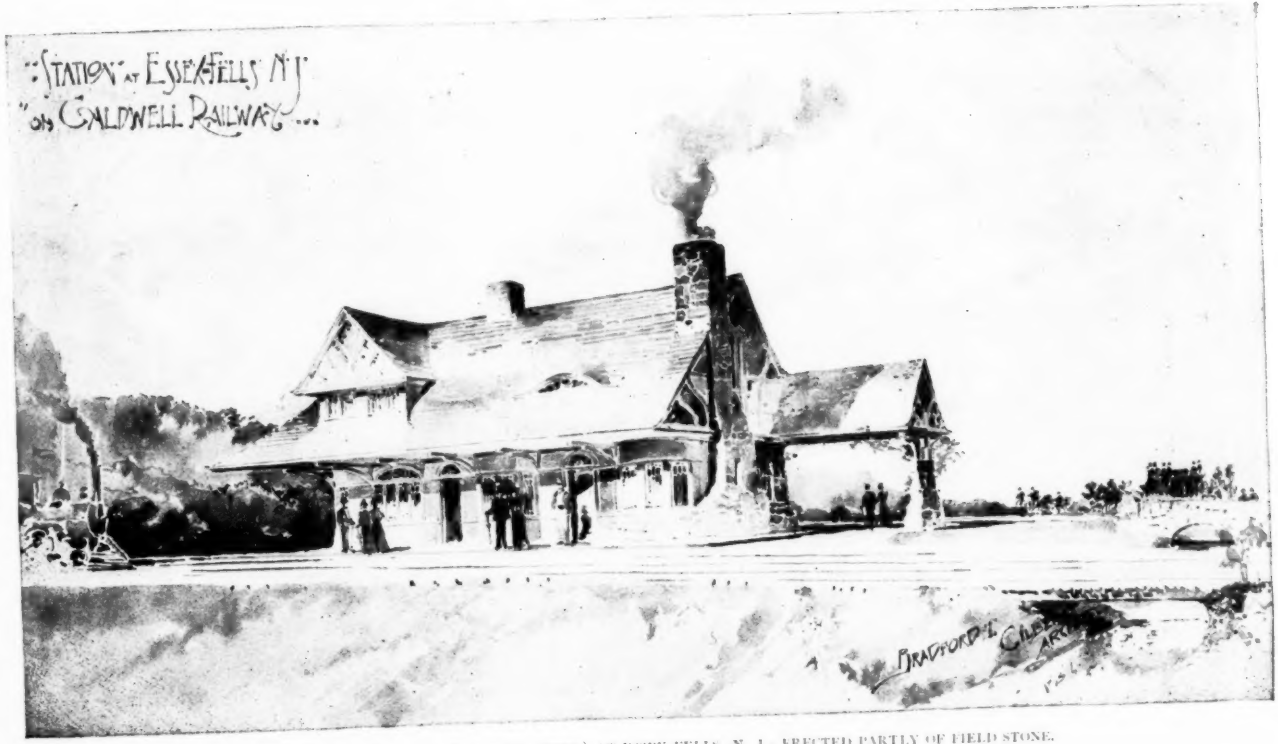
STATION AT NORTH BRANCH, N. J., ON THE CENTRAL RAILROAD OF N. J., ERECTED OF FIELD STONE.

STATION AT TOLUCA, MEX., ON THE MEXICAN NATIONAL R. R.

CENTRAL DOME OF GRANITE STATION AT LACONIA, N. H.,
ON THE CONCORD AND MONTREAL R. R.

STATION, RESTAURANT AND LOCAL OFFICES AT MIDDLETOWN, N. Y., ON THE NEW YORK, ONTARIO AND WESTERN R. R.

STATION AT BRIDGEWATER, MASS., ON THE NEW YORK, NEW HAVEN AND HARTFORD R. R., ERECTED OF MILFORD GRANITE AND BROWN STONE.

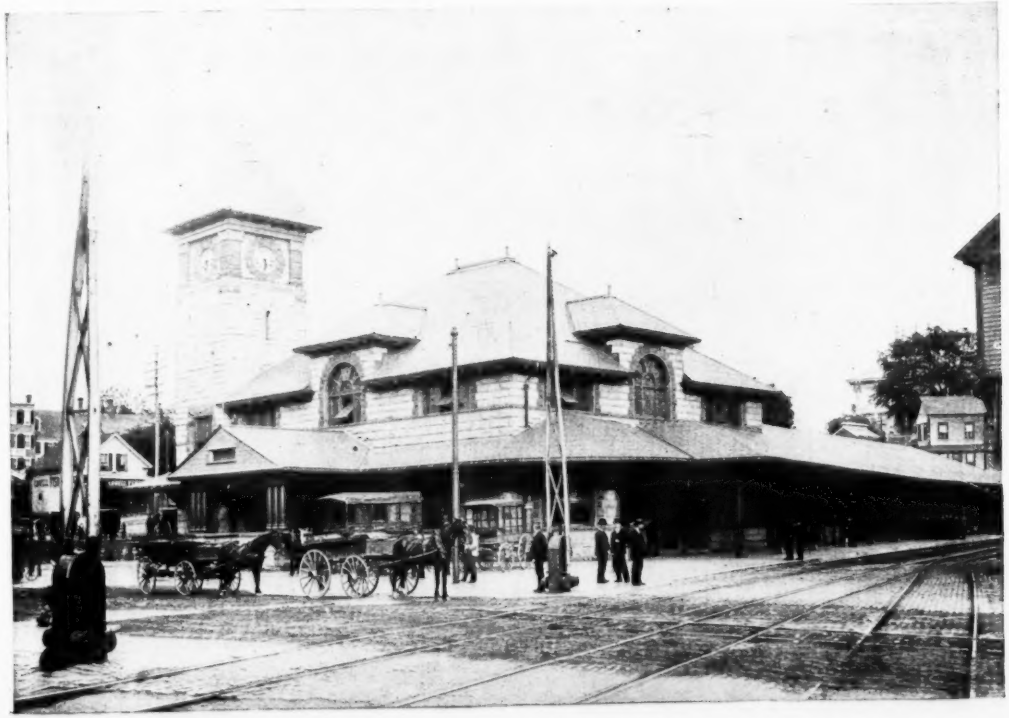


STATION (WITH AGENT'S ROOMS OVER) AT ESSEX-FELLS, N. J., ERECTED PARTLY OF FIELD STONE.

STATION AT NEW BOSTON, MASS., ON THE CONCORD AND MONTREAL R. R.

UNION STATION, LOCAL OFFICES AND TRAIN SHED, FOR MANCHESTER, N. H.

FRAME STATION WITH DOUBLE BAGGAGE ROOMS ERECTED AT LIBERTY, N. Y., FOR THE NEW YORK, ONTARIO AND WESTERN R. R



TRIANGULAR STATION (TRACKS BOTH SIDES) AT LOWELL, MASS., ON THE BOSTON AND MAINE R. R.

GRANITE STATION AT FALL RIVER, MASS., ERECTED FOR THE OLD COLONY RAILROAD CO. PHOTOGRAPH SHOWING DETAIL WORK AND CARVING OF PORT-COCHERE, LOGGIA TURRET, ETC.

THE ADVANCE IN RAILROAD SECURITIES.

By Thomas L. Greene.

THE great advance in quotations for stocks and bonds which began in April, and which has affected almost every security dealt in on the stock exchanges, is a movement of the first importance to the railroad industry. To show how general has been the advance and to what extent it has gone, the following table, covering a number of typical railroad shares, has been compiled:

Stocks.	Lowest Price in 1895.	Price June 1, 1895.	Advance during 1895.	Percentage of advance during 1895 (fractions omitted).
Atchison, T. & Santa Fé	3½ Jany.	7⅝	4⅛	118%
Balto. & Ohio	49 Mch.	62	13	.27%
Ches. & Ohio	16 Jany.	22⅝	6⅝	41%
Chi., Bur. & Quincy	69 Mch.	81	12	20%
Chic. & No.-Western	88 Mch.	99	11	.13%
Chic., Mil. & St. Paul	54 Mch.	67	13	24%
Col., Hocking Valley & T.	16 Jany.	26	10	62%
Denver & Rio Grande	11 Jany.	15¼	4¼	40%
Illinois Central	82 Jany.	97	15	18%
Lake Shore & M. S.	135 Jany.	146	6	....
Louis. & Nashville	47 Mch.	58	11	24%
Missouri Pacific	19 Mch.	28	9	47%
New York Central	93 Mch.	101	8	9%
Norfolk & Western	2 Mch.	4	2	100%
Northern Pacific	2½ Jany.	5½	3	120%
Phila. & Reading	7½ Mch.	19	11½	153%
Texas & Pacific	8⅛ Jany.	12½	4⅜	54%
Union Pacific	7¾ Mch.	14⅛	6⅜	82%
Wabash	5⅜ Mch.	9¼	3⅞	72%

We may for a moment turn aside from the general subject of the all but universal advance, to notice an interesting fact shown by the last column in the above table. There is not so great a difference between the stocks named as to the advance in points, but the percentage of that advance varies greatly, being by far the largest in the low priced shares. We have here an explanation why low priced shares are favorite purchases for speculators when a "bull" movement has begun. Money put into Norfolk & Western or Northern Pacific common stock for illustration was more than doubled; the same sums used to buy Chicago, Burlington & Quincy yielded a profit of 20 per cent. only, while the profit in Lake Shore was infinitesimal in comparison.

So complete a revulsion in feeling, following the gloom of February, is due in part to the work of the Morgan-Belmont syndicate; in part

to the natural sentiment of mankind, which leads people to feel more hopeful in the spring of the year when nature's life is reviving; and in part also to the unmistakable signs of a gradual return to a normal volume of business in manufacturing and trading.

This is, indeed, only another way of saying that the advance is anticipatory,—that Wall street has, in financial parlance, "discounted" the future; yet the phrase is worth a little discussion. It implies the belief on the part of Wall street that general business will slowly improve, and that the railroads will share in the improvement. As to the probability of a larger volume of commerce, the opinion is general that Wall street is correct in its surmise. The United States, for two long years, has been settling down to a low level of prices, profits, and mercantile credits. The fact that mills are starting up and other enterprises, old and new, are resuming or beginning new work, even though not in full, is evidence that the volume of business will ere long increase. It is true that the margin of profit is small, and that it may continue so for a while; yet a beginning has been made, and a large return to our industries will follow in time.

All this means a larger volume of traffic to our railroads. The shelves of the country stores are, in general, bare of goods, so that at a slight demand a better movement in supplies and manufactured goods will set in. Very much will depend upon the fall crops; yet even in this respect Wall street, with its usual swing, thinks that there is nothing now to fear. Almost everybody is looking for a carrying-trade next autumn which will give all the railroads plenty to do. It is also probable that freight rates, now so low under "cutting" and the force of circumstances, will be higher then. Not that the printed schedule will be changed,—grain and cotton are being grown at too small a profit for that,—but that the printed rates will be more generally maintained. Competing carriers always fight hardest for a volume of traffic which is not enough to "divide around." A small advance in the average rate received, and an increase in the quantity carried, would, as everyone can see, give larger gross earnings as well as an advance in the proportion of profit, so that some jubilation is clearly admissible. And if, in addition, we look further ahead, and, arguing from the past, think what an active and intelligent people may accomplish in a land whose resources are far from being exhausted, it is but fair to say that the expectations for the far future of financial speculators (using the word in its good sense) have a substantial basis.

But there is another side to this picture. In the United States no single industry has suffered as much as that of the railroads for the past two years. Perhaps upon this point it is better to quote the official

language of the Inter-State Commerce Commission's statistician. In his preliminary report for the year ending June 30, 1894, he remarks as follows:

> On June 30, 1894, there were 156 railways in the hands of receivers, of which 106 passed into the hands of receivers during the year ending June 30, 1894, and 28 during the year ending June 30, 1893. The mileage of road operated by these defaulting companies is 38,869.96 miles. Eighty per cent. of this mileage is accounted for by 28 important lines. Of the 128 remaining, 59 were small lines of less than 100 miles in length, some of them being parts of larger systems, and some being lines still in process of construction. The total capitalization of roads in the hands of receivers was about $2,500,000,000, or about one-fourth of the total capitalization of the country.

Since January 1, 1895, two railroads, the Norfolk & Western and the Ohio Southern, have confessed insolvency. Thus something more than one-quarter of the railroad companies in the United States have during the past two years been more or less embarrassed,—a very large proportion when compared with the number of business men who have failed, which was something less than two per cent. of the whole number. It is not the purpose of this paper to discuss the reasons for this large percentage of failures in the railroad industry, but merely to note the fact, with some comments upon the results for the present and probable future. To set the situation down in actual figures, there is no better way than to make use of the statistics of the Inter-State Commerce Commission again. Below is a table of income and disbursements, calculated per mile, for three years, from the commission's reports:

U. S. RAILROAD INCOME ACCOUNT PER MILE.

	1892.	1893.	1894.
Passenger earnings	$2,104	$2,120	$2,067
Freight earnings	4,946	4,906	4,132
Other earnings	163	164	151
Total gross earnings	7,213	7,190	6,350
Operating expenses	4,809	4,876	4,302
Income from operation	2,404	2,314	2,048
All deduction for fixed charges, less "other income."	1,690	1,660	1,837
Net income	714	654	311
Dividends paid	628	606	418
	*$86	*$48	†$207

* Surplus. † Deficit.

These figures are for the government years ending June 30. In the

year ending June 30, 1894, the effects of the business depression are plainly visible. Although the total amount of dividends paid was reduced one-third, the average result was a deficit of $207 per mile ; in short, but $104 per mile was earned in that year for the shareholders, as compared with nearly six times that sum in 1892 and 1893. It is to be feared that, when the statistics for 1895 come to be compiled, they will, as a whole, present even worse results than those of 1894. But, since the last months of this fiscal year show increases in gross earnings generally, there is every hope for the future.

The items in this table, "all deductions for fixed charges less 'other income'" need a little explanation. The preliminary report for 1894 does not give this information, but we have the details for the two previous years :

STATEMENT OF DEDUCTIONS PER MILE.

	1892.	1893.
Interest on funded debt	$1,478	$1,475
Rents	629	632
Taxes	209	215
Interest on current debt	49	47
Improvements paid for from revenue	25	17
Other payments	174	155
	2,564	2,541
Credit by "income from other sources"	874	881
Deduction as per table given above	$1,690	$1,660

The item of taxes per mile could scarcely have been less in 1894 than in the previous years, and was very likely more. Taking the item as $215 per mile, we have the rather startling result that the taxes paid by the railroads on the average in 1894 were twice the amount earned in dividends per mile, and were but one-third less than the total called "net income." Moreover, taxes, whether chargeable to operating expenses or not, are not payments on capital account; hence the sum named for 1894 as "income from operation" is stated at too high a figure, if by that term we mean the amount which capital in one form or another appropriates to itself. Neither should improvements paid for from revenue be included under that term so defined. Altogether the sum earned from operation in 1894 was small, and, being given per mile, is independent of the question of "water" in the capitalization.

Extending our gaze from 1892 to the close of the fiscal year ending June 30, 1895, we know that a number of those companies which have

escaped insolvency, or which have continued dividends, have succeeded in so doing only by heroic remedies. Equipment has been neglected, the road-bed left to deteriorate under inadequate care, and, in short, the plant has fallen—in some cases fallen greatly—behind the standard. To bring this plant up to the former level, and indeed to carry the anticipated heavier traffic at all, money must be spent, and spent liberally. Those companies which can afford it—and this is one of the advantages of capital or credit—will take advantage of the prevailing cheapness of material, and begin at once to repair cars and engines and to replace worn-out properties, knowing well that the same work next year will cost them 20 per cent. more. The new money which will in all probability be thus spent by certain of our best companies will give additional orders to rail mills, to car shops, and to supply-men generally. The beneficial effect of such expected expenditures upon general business will be important, for the severe curtailing of railroad orders has borne most heavily upon a worthy class of manufacturers who in times past depended largely upon railroads for the sale of their product. The depression in volume of trade which we have been experiencing since 1892 has been caused in no small degree by this compulsory stoppage of orders and discharge of employees on the part of our largest industry. We are apt to forget that from 1880 to 1890 there were built in the United States approximately 75,000 miles of new railroad. If we consider what this means,—how many tons of rails, how much material, how much land purchased, how many laborers employed in construction, how much food for these men, how much revenue to the older railroads which carried breadstuffs one way and rails and all kinds of supplies the other,—if we consider all this, we shall be the better prepared to put the prosperity of the railroad industry high on our list of causes of general good times, and the more willing to look forward hopefully, if we believe that these same railroads will once more be justified in spending some of their money for construction of new lines or reconstruction of old ones.

That something of this kind will happen on the better class of roads, we may believe. But about the majority of companies—how will it fare with them? That question cannot be answered easily. Many a company which sees the opportunity plainly enough will have no money to spend, even to anticipate the autumn requirements or those of the future. Such railroads ought to spend this money before they earn it. In a majority of cases the losses of 1893 and 1894 (including the required replacement of equipment and property) will probably be funded into bonded debt by the issue of new mortgages or by the sale of old bonds from the treasury. In time, if things are again prosperous, that increase in funded debt can be practically made

up out of earnings by taking from those future earnings, if the company will, and putting into the property the sums thus formerly transferred under stress from income to capital. It is at this point that the advance in Wall street quotations will prove important, for it will in time allow the roads pressed for money to sell their securities at fair prices and to apply the funds thus obtained to the repair of equipment, when needed, or in anticipation of that need. Those companies which for any reason have not this resource must suffer the attendant disadvantages.

It is probable that our railways, as a whole, will be operated somewhat more cheaply in the immediate future than in the past. The prosperity which was ours up to 1893 was not conducive to economy, at least, not to that kind which requires careful study both of broad plans and of details. "Sweet are the uses of adversity," and in the present case adversity has taught us points in the economics of railroad-working hitherto unexpected. Some of these points have already been well treated in the ENGINEERING MAGAZINE. But one possible source of future economy has not been widely discussed, and may well be mentioned now. I refer to the necessity for a reduction of grades. The lading of the train has only lately received from railroad officers the attention it has merited. The engines, it is safe to say, are now hauling loads which are nearer to their theoretical capacity than ever before. But on many roads that capacity is still seriously limited by the gradients. It may be that on a division there is a governing grade and perhaps but one, which limits the number of cars hauled over the whole division, or at least necessitates the use of a pushing locomotive. Why are not such grades removed? The railroad officers know the situation well, and very likely the chief engineer has prepared tables, based on the average movement of trains, which show that the cost of removal of such grades would be made up in a few years by the saving in operating expenses. The reason why such recommendations are not followed is, of course, the lack of capital. But, if railroads are to be again profitable, and if we believe that freight rates in the United States are to be regarded as permanently on a low plane, it will only be a matter of time when questions of this character will become burning ones. Assume for a moment that normal business is once more with us; assume also that the companies have been obliged to put back into the property the money taken from it by a "forced loan" during the depression; assume that this loan has been transferred to the public by the issue of bonds sufficient to cover the expenditure,—a thing which the recent advance in prices may render possible; assume all this, and we still have a question before us of the first importance. Will the margin of profit support the

capitalization, including the new issues, and at the same time allow the keeping of the property at the required standard? It is a question which only the future can answer. A great deal will be done in this direction by the economies in operating already mentioned, but will these go far enough to accomplish the purpose? Time alone can tell.

If the answer to this question should turn out to be adverse to any considerable number of railroads, it is not impossible that, as a result, we shall be found entering gradually upon a new era in railroading. More and more in all lines of business are we realizing our dependence upon credit and capital. As manufacturing tends to become centered into larger corporations, so it may be with the railroad industry. Additional capital to cut down grades, and in other ways to reduce operating expenses, may become a necessity; while at the same time perhaps through those who deal in capital on a large scale the means may be found by which harmony may be secured between the warring companies. To call such a nebulous plan by a name would be to confine a mere thought within limits. Consolidation has a definite meaning, and might be difficult to carry out. If it should happen that cutting of rates and reduction of revenues should go on until the weaker roads were nearing exhaustion; and if also a union of capitalists should allow of help in some form at such a juncture,—we may see a marked change in the general situation. Meanwhile, the advance in the quotations on the stock exchanges expresses the general confidence of the public in the ultimate future. Speculation accounts for the fact that the cheapest shares have had the greatest rise. The next stage, at some time in the future, must be discrimination between one company and another or one security and another, depending upon the outcome as to the margin of profits in each particular case after normal conditions, both as to property and as to traffic (though not necessarily as to rates), have been restored. If that margin of profit is found sufficient, things will go on smoothly; if found insufficient, then some remedy, perhaps on the lines already suggested, will be found.

THE CAR-BUILDING INDUSTRY OF THE UNITED STATES.

By John C. Wait.

THE subject of car-building is not one that appeals to the interest of the general public. It has no such significance as the industry of ship building, and no such importance is attached to it by the people. An act of congress to promote the car-building interests of the country, for example, would be a decided innovation.

The reasons for this are several. One is, no doubt, that a car is a common-place object familiar to all, especially an ordinary freight-car. On the other hand a ship is a small universe of curiosities,—an object of profound admiration because of its colossal dimensions and the dangers through which it passes. A car has no traditions enveloping it, no legends surrounding it. With the navy the people are wont always to associate the protection and preservation of our country. But never a thought is given to the wonderful part that a freight-car may play in the mobilization and supply of an army. Yet, in case of invasion of our territory, the vehicles of war that would save the nation would be these same despised freight-cars, and an industry that would figure quite as much in the preservation of our country as any other would be the car-building industry.

A brief, but careful, consideration of the relative importance of the two industries mentioned may create a different sentiment among the people. In 1890 there were 1010 shipbuilding establishments in the United States with an aggregate capital invested of $53,393,074, employing on an average 25,934 employees who received $16,028,847 in wages; while for the same year 882 car-building and car-repair plants represented a total capital of $124,653,164, gave employment to 144,514 persons, and paid $81,243,363 in wages. The car-building interests represented twice the capital, employed five times the number of persons, and paid five times the aggregate wages. The impression of the magnitude of the individual ship-building establishment created from association with the government navy-yards and the Cramps' ship-building plant, needs to be corrected by knowledge of the fact that the average value of the ship-building plants of the country, including land, buildings, and machinery, is only $394,158, while that of the average car-building plant is $861,054.

The cost of materials used in ship-building was $16,925,109, and the value of the product, including repairs, was $40,342,115; while

the materials used in the construction and repairs of cars amounted to $114,090,087 and the manufactured products turned out were valued at $205,813,897.

In 1893 the tonnage of the transatlantic steamships combined was about 2,250,000, while in the United States and Canada there are over 1,340,000 freight-cars with a tonnage estimated at more than ten times that of the transatlantic steamship companies. In the face of these facts and statistics, it is difficult to understand how anybody can fail to appreciate the importance of one of the largest industries of the continent,—an industry that ranks sixth among the mechanical and manufacturing industries in the number of employees, eleventh in the capital invested, and tenth in value of products.

Previous to the year 1893 car building had long enjoyed a very profitable business. One company began in 1849 with $10,000 cash and a tract of land valued at $10,000 ; after 42 years of business, and without any additions to the capital from any extraneous source, owned property worth nearly $3,500,000, exclusive of surplus profits arising and paid in the regular course of business. The profits for the 6 years and 1 month ending July 31, 1891, amounted to $2,321,163, or a yearly average of considerably more than 12 per cent. The assets of this company on December 1, 1893, were $5,224,178, and its plant comprised 28 acres and 40 buildings, and employed nearly 2000 men.

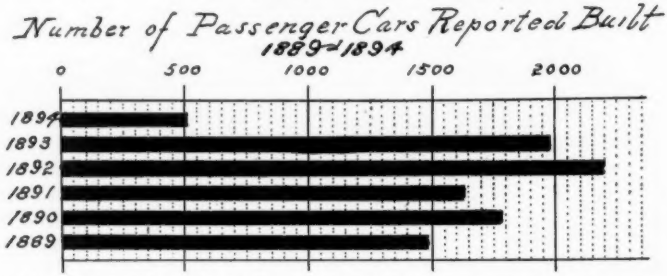
One of the largest freight-car-building establishments reported has a plant which comprises 83.5 acres, and 78 buildings, employs 5000 men, has a capacity of 100 cars per day. The total assets of this company in 1893 were estimated at $11,000,000, and it paid earnings amounting to $1,062,382, or nearly 10 per cent. of the investment. A third company reported in 1893 a total investment of $2,500,000 and a yearly output of $3,000,000. It employs 2000 men, and has a capacity of five passenger- and twenty-five freight-cars per day.

These three companies may not faithfully reflect the prosperity of the industry, as a whole, but they do show that car-building for many years has been a profitable business, and that the growth of some companies has been almost phenomenal.

Until 1893 the car-building companies were fully able to take care of themselves, but since then the market has been at its lowest ebb. In 1890 there were 71 car-building companies engaged in making steam-cars, not including railroad shops. These companies had a total capital of $43,641,210, of which $3,811,086 was invested in land, $7,878,189 in buildings, $7,626,804 in machinery and tools, and $24,325,131 in live assets. The number of men employed was 32,062 and the wages paid $16,836,531, or $1.70 per day,—306 days

to the year to all employees. The cost of materials used was $44,674,486, and the output $70,083,737.

The accompanying diagrams (pages 682 and 683), show the number of companies which reported their business to the *Railroad Gazette* for the years 1889 to 1894; these companies represent probably 90 per cent. of the annual product of the country. The diagram shows that, for 1889, 40 of these principal companies built 130,881 freight-cars and 1484 passenger-cars. For three years thereafter bountiful crops and the Columbian Exposition kept the industry alive, and nearly 100,000 freight-cars and from 1500 to 2000 passenger-cars a year were built. In 1893 only about one-half the number of freight-cars were built. The effect of the World's fair on passenger-car work, in keeping the product almost up to the 2000 mark, may be seen in the diagram. The drop from 100,000 freight-cars in 1892 to 17,000 in 1894, and from 2000 passenger cars in 1893 to 500 in 1894, is also shown by the diagram, as plainly as words can express it. It may be



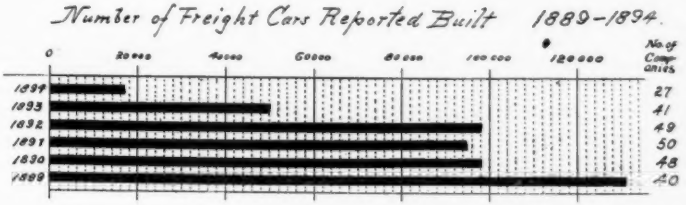
added that one-third of the steam-car-building plants that take contract work have been shut down.

Probably at no time in the history of our country have the ship-building interests been so depressed as have the car-building interests during the past year. The fact that our car companies have had business for many years and have done it at a profit augurs well for the future. They have not only supplied their own country with cars, but entered into competition with European countries for foreign car work; and, where the competition has been free, American cars have taken precedence. It required only a careful study of the cars exhibited at the Columbian Exposition to convince even an Englishman of the superior class of work offered by our car companies, and Americans may well take a native pride in the fact that our railroad equipment is unexcelled by any in the world, either in design or quantity.

The leading military and railway nation of the Continent, Prussia, in 1892 had but 205,476 cars, of an estimated tonnage of 1,233,000

tons, each car being of one-fourth to one-fifth the capacity of American cars. In 1891 Russia had but 7,788 passenger cars; in the U. S. there are nearly five times that number. If the car equipment is in proportion to the mileage of the railroads, America may well feel herself proud. The total mileage of the whole world is estimated at 406,416 miles, of which America has 218,910 miles, excluding side tracks and sidings. The United States alone has 228,852 miles, if the side tracks and sidings are included, and the elevated railroads of New York are omitted.

To fully appreciate the magnitude of the car building industry let us inquire what it includes. It includes, first, the erection of from 60,000 to 120,000 cars a year, and the repair and renewal of parts of about 1,400,000 cars that are in almost constant service. It includes the manufacture and supply of all the couplers, draft-rigging, wheels, axles, brasses, doors, and roofs, and for passenger cars a multitude of furnishings, including lamps, seats, heating and lighting apparatus, brakes, and vestibules.

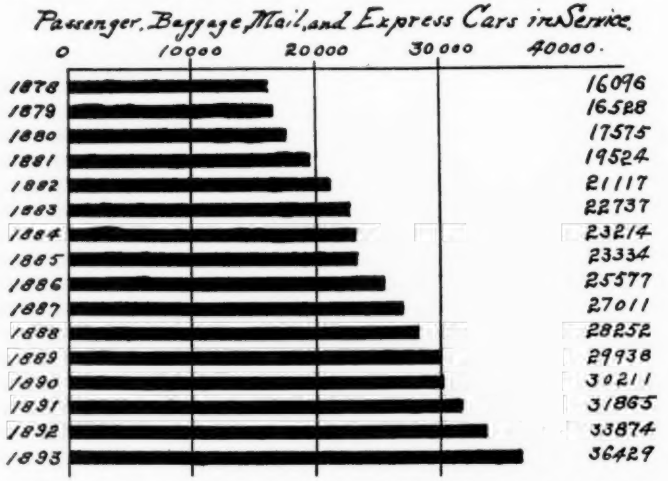


In January, 1895, the aggregate number of cars in service in the United States and Canada was, (see pages 684 and 685), about 1,406,321, of which 1,208,770 were included in the equipment of railway companies, 164,987 were in the service of transportation companies, and 32,564 belonged to private companies or individuals. This equipment represents an investment of not less than $750,000,000, and requires for repairs and renewals a sum approximating, $70,000,000 per annum. To do this re-building and repairing requires 100,000 men, who receive $1,500,000 per year, and, though generally classed as car-repairers, may certainly be considered as belonging to the car-building industry.

The renewals alone require the annual production of about 1,500,000 wheels, 175,000 axles, and of course an immense number of journal bearings, springs, bolts, and iron parts worn out or broken.

A still better comprehension of the countless number of cars may be had when it is considered that they would make two continuous trains or structures reaching from Boston to San Francisco, and that, in

time of war, our government could establish with the rolling-stock at hand a continuous train of cars running both ways across the continent with a locomotive to every forty cars. Such a transcontinental train would not include several hundred thousand or more of street and suburban cars, of which there are some 54,000, including motors, in the State of New York alone.

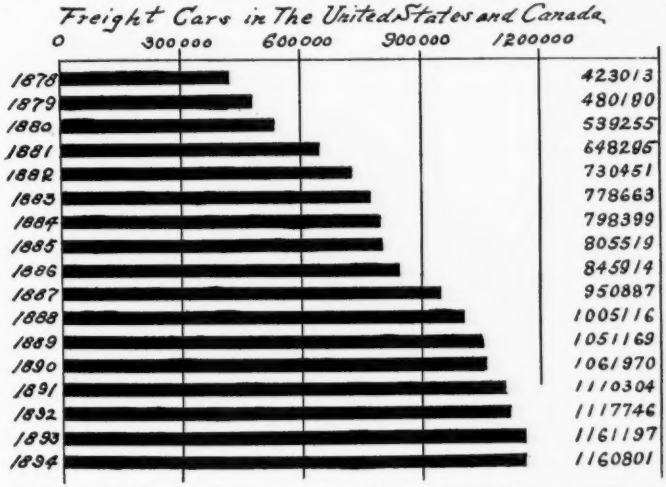


The chief car-building plants, and indeed the bulk of the car-building business, is carried on in the middle and central States within the territory bounded by the cities of Chicago, Detroit, Buffalo, Troy, New York, Philadelphia, Huntington, W. Va., Cincinnati, and St. Louis. In 1890 about 75 per cent. of the cars built in the United States were built within these limits, and it is estimated, after careful inquiry, that fully 90 per cent. of the cars built in the past year were built in this territory. This is due chiefly to the fact that this is the manufacturing district of the land, but also to the fact that fully 65 per cent. of the equipment owned by railroads and 75 per cent. of the total equipment of the country are owned or controlled within it.

The car companies which best endured the panic of 1893–4 are those located in the large coal, iron, and lumber markets or in close proximity to the fields supplying these materials of construction. Coal at 90 cents or coal at $2; iron at the furnace or rolling-mill, or iron from the merchant, or with transportation added; lumber by the raft, at the dock, or out of the yard,—these things very quickly decide the lowest bidder in a close competition.

An important, yet secondary, factor is the labor, its ratio to that of the whole cost of a car being about one-eighth. Its cheapness depends largely upon the location. Car shops generally are near large cities, where skilled labor can be had at short notice. To cheapen the cost of labor, car companies and other large manufacturing interests have purchased large sites in isolated and unimproved sections near large cities, and established their plants where house lots and living may be had at a minimum cost. Labor so situated is expected to be content with less wages, to the profit and advantage of the company employing it.

The most familiar of such car-building settlements is that of the Pullman's Palace Car Company at Pullman, Illinois, where the company enjoys close proximity to rolling mills and the great lakes lumber



district, and has direct connection with a dozen different railroads leading to coal and coke fields. There are several such plants in the country, one of the largest being that of the United States Rolling Stock Company at Hegewisch, Ill. The Canda Car Company at Carteret, N. J., The Harvey Steel Car Company at Harvey, Ill., and The Union Car Company at Depew-on-the-Hudson, are plants recently established after the same plan. A plant so established can better afford to take work at an unprofitable price than to have its houses vacant or let the town go to decay.

To such proportions has the supply business grown that the car builder has become little more than an erector, instead of the manu-

facturer which he was originally. It happens not infrequently that the work of the car company consists in furnishing the wood and iron work and doing the framing and forging, and it is not unusual for a railroad to specify the parts so explicitly that the car-builder must procure them from a particular source, when the advantage of a central location is apparent, saving time and expense.

The chief and distinguishing feature of American cars is their large size, the capacity of our new cars being from three to five times that of European cars. In 12 years the capacity of freight-cars has been increased by one half, and this growth in capacity has required corresponding changes in detail, so that the establishment of standards has been well-nigh impossible.

Motive-power superintendents and master car builders now feel that cars are large enough, and that more is to be gained by railroads in adopting standards and standard details than can be gained by further increase in the size of cars. Whether they will have the determination of this important question seems doubtful. Transportation companies and large shippers who furnish their own cars, which are hauled by the railroads as a car, find cheaper rates in larger cars, and an increase of a few tons in the capacity of a car means a very large increase in the net tonnage for a year. Without any other motive apparent than the gain of tonnage at the expense of the roads, and without any pretence that the operation of heavier cars is any more economical, these companies are urging heavier and larger cars, which shall carry 70,000 to 80,000 lbs., and weigh, when loaded, from 100,000 to 120,000 lbs. The length proposed for such cars is 40 or 42 ft.,—height and depth to be slightly larger than at present. To get the business of these companies, not only do railroads consent to haul large and ponderous cars, loading their track structure to the extreme limit of safety, but the traffic departments are said to be quietly urging the mechanical departments to provide such cars as a bid for the business. If persisted in, this will inevitably result in much larger cars and postpone the adoption of standards.

The only limit to the size of cars will be the limiting cross-sectional area of the tunnels and track structure and the curves of the double tracks. This, as has been shown by Mr. Theodore Cooper, in a paper read before the American Society of Civil Engineers (Proceedings, Vol. 31, p. 174), will be a car about 42 ft. long and weighing not more than 4000 lbs. per linear foot of track. Such a car will weigh nearly 170,000 lbs. In anticipation of such a car, Mr. Cooper suggests that 4000 lbs. be taken as the maximum loading for trains on one-track structures.

The tendency to simplify the construction of cars by lessening the

number of parts is growing more pronounced among car-builders and designers. This is shown by the general adoption of the rigid diamond truck in preference to the swing-motion truck. Another tendency is to do away with the multiplicity of parts by making one pattern or shape do duty for several castings. This is illustrated by doing away with rights and lefts of many parts in the same car, and using the same sizes and shapes in several structures, even though they be a trifle too heavy or too strong for some of them.

The long-looked-for adoption of iron for freight-cars has not yet been realized in this country, but it is certainly gaining favor among the mechanical departments. The prejudice that has existed is wearing away, and iron and steel are freely used in the form of flitch plates, reënforcing bars, and angles in both freight and passenger bodies as well as in the trucks. Iron in these shapes is certainly gaining favor, and by the time railroad corporations feel able to pay the extra first cost of iron over that of wooden cars, no doubt the car builders will be in full sympathy with the change. With our repair shops equipped with tools and men for doing iron work, and with a standard size determined, the adoption of iron cars will be assured.

In answer to the question put to the car builders of the country: "What do you consider the prospect for a revival of car building for 1895–6?"; the answers were almost unanimous that the prospects were "*fairly good.*" This feeling must be based upon the assumption that the railroads have ordered little equipment for the past two years, and that they will require new cars to take the places of those condemned or destroyed.

There is other work in sight, too. Of the number of cars owned or operated by the railroads of the United States, given by the Inter-State Commerce Commission as 1,273,946, of which 31,384 are in the passenger service, only 271,367 are fitted with train brakes. This number includes 30,562 passenger-cars, or 97.3 per cent. of the cars in passenger service, and only 20 per cent. of the freight cars. Doubtless this number does not include the equipment of transportation companies, which, as shown by the foregoing table, amounts to 165,000 cars, in round numbers. The Westinghouse Air-Brake Company claims to have its brake in service on 27,000 locomotives and 408,000 cars, which is less than one-third of the total car equipment of the United States and Canada. The application of train brakes will afford work for the brake companies.

The coupler question is one that will require the attention of both car builders and supply men. Only 2½ years remain in which to comply with the legal requirement that the old link-and-pin drawbars shall be replaced by the automatic coupler, on all cars engaged in

Inter-State commerce. As nearly all the freight equipment and a good deal of the passenger equipment are engaged in such traffic, it may be assumed that the change will be complete.

The commission reported in June, 1893, that 318,302 cars were equipped with automatic couplers, and that 30,446 of these were passenger-cars. That will leave, according to their figures, 955,644 cars to be supplied with couplers, to which may be added a great number belonging to transportation companies and to individuals.

The heating and lighting of cars is another subject which will afford car builders considerable care and labor. Legislation is likely to be enacted in all the States which will require the introduction of steam-heating plants. Gas-lighting continues to gain favor, wherever adopted. It is now in use on nearly six thousand cars, or about one-fifth of the passenger equipment of the country.

In looking at prospective work, the pressed-steel industry should not be overlooked, for it has many friends in the car-building circles; nor the steel-tired wheel industry, whose wheels are now applied to about 36 per cent. of the passenger equipment; nor the car roofing companies; nor the car-door business; nor the companies making and furnishing vestibules.

In conclusion, it may be said that, as broad and comprehensive as the subject of car building may seem, there is much that has not been touched in this paper. The quantity of furnace, rolling-mill, and foundry products which it absorbs; the oils, paints, and varnishes applied to its cars; the plushes and furniture used for furnishing; the lamps and the many fittings and appliances necessary to make a car complete,—are not included in the above statistics. The labor employed and the capital invested in the production of these supplies would swell the figures already given beyond all comparison with other industries. Without these the car-building industry of our country should receive the recognition which it justly merits. It needs an occasional depression of railroad business to bring the public to a proper sense of the close relationship which exists between the prosperity of the nation and that of the railroad interests, and of what an important part the car-building industry of the country bears to the railroad interests as a whole.

A GLIMPSE OF "THE SILVERY SAN JUAN."

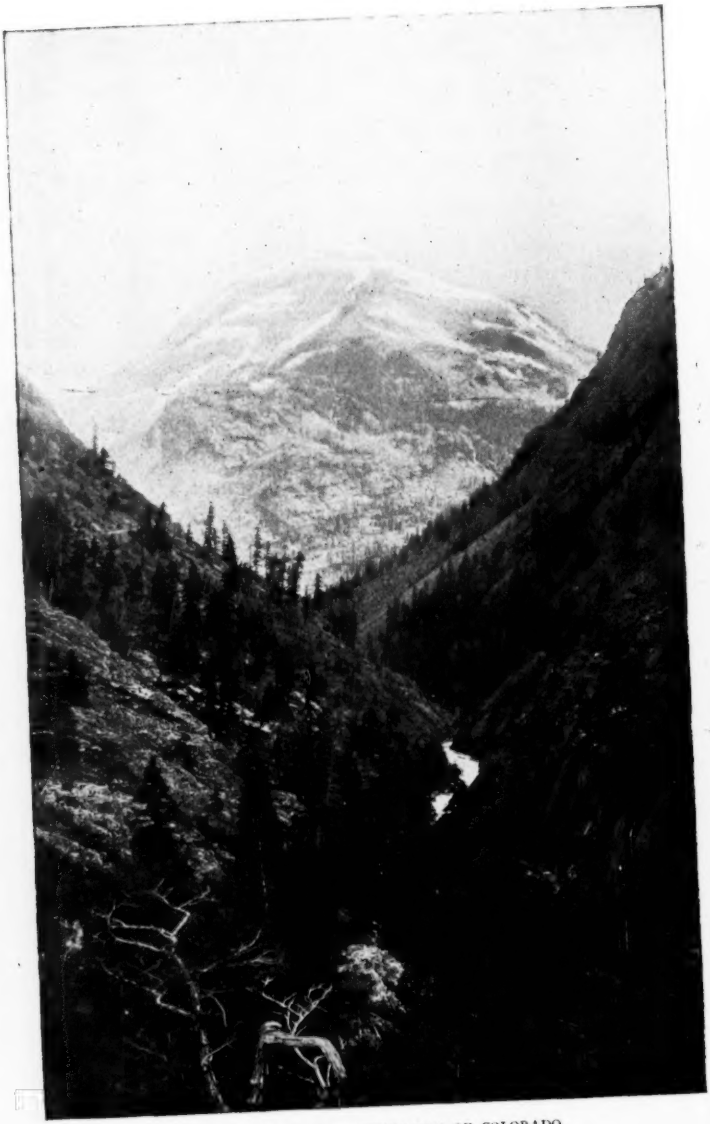
By T. A. Rickard.

THIS, the most picturesque part of Colorado, forms the south-western division of the great mining region stretching from Hahn's Peak to the New Mexican border. Though this rugged mountain land is the Switzerland of the West; though it possesses beauty for the artist and wonders for the scientist,—it is nevertheless unknown to many who in their hurried transit from the Atlantic to the Pacific adhere to the main trans-continental lines of travel. Even the citizen of Denver too often knows the San Juan merely as a rich mining district, and has but the vaguest idea of the grandeur of snowy summits, dark ravines, and forest-clad hills which will forever remain as a heritage of loveliness to him and his.

This region was named "the silvery San Juan" a few years ago, when the Yankee Girl, the Guston, the Enterprise, the Rico Aspen, the Smuggler-Union, and other famous mines were sending their daily tribute of gold and silver to the marts of the world. Recent events have given the adjective "silvery" the sound of an unkind cynicism, which is being brushed aside by the renewed confidence afforded by a successful development of gold mines, the output of which is winning the newer name of "the gilded San Juan."

To many the changed direction taken by the energy of the mining communities of this and of other parts of Colorado, as evidenced in the transference of work from silver to gold mining, is a puzzle and a continual wonder; to others it is a fit subject for iridescent editorials and misleading newspaper articles. Silver mining has been for a time seriously crippled. The present production of the State is derived largely from ores wherein the two precious metals are closely associated. When a silver mine is said to have become a gold mine, it is often due, not to any new discovery or wondrous transmuting of the one metal into the other, but simply to the plain commercial fact that the fall in silver has so diminished the market value of the silver contents as to proportionately increase the relative value of the gold contents and render the ore more valuable for its appreciated than its depreciated metal.

Nowhere have the flimsy romance and the stern reality of mining been so strongly contrasted as in the stirring tales that tell the story of



MT. ABRAM—THE MATTERHORN OF COLORADO.

THE DIFFICULTIES OF A MOUNTAIN TOLL-ROAD.

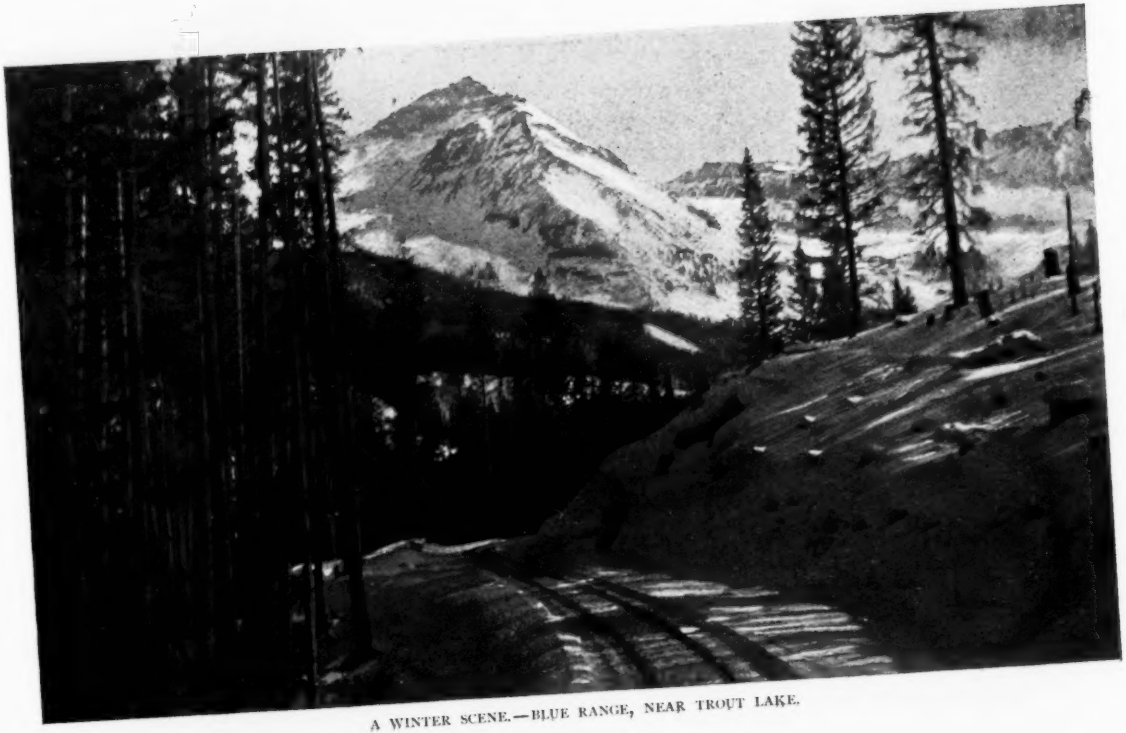
A tunnel in summer through a snow-slide which came down the mountain in spring.

the discovery and development of the San Juan region. Of the great tide of immigration which swept westward after the financial panic of 1857 one wave broke over the Sangre de Christo range and, penetrating the San Luis valley, invaded what is now the San Juan. Tim Baker, scout and trapper, led a party to the headwaters of the Animas in 1861. Baker's park, the site of the present lively town of Silverton, perpetuates his memory. In 1872 mining operations began in earnest. In those days railroads were unknown, and mountain trails few and hard to follow; the nearest smelter was on the further side of two snowy ranges, and transportation, even in good weather, occupied at least 20 days; work was done in the summer months only, and the beginning of every winter saw an exodus to lower altitudes. The San Juan was uninhabitable during half the year, because defective communication rendered it impossible to obtain the necessary supplies, and it was only as the toll-roads penetrated into the heart of the hills that life became bearable or even safe.

In this connection it is interesting to note the remark made in one of the early government reports that the cañon of the Animas below Silverton was impassable to man and mule. That very cañon to-day echoes to the wild shriek of the locomotive, and throws back the thunderous rumble of swiftly-passing Pullman cars. And so we smile at the statement of the government surveyor of 20 years ago. Yet remember that at that time even the cat-like Indian climbed the upper cliffs rather than follow the gloomy defile into which the heedless river rushed. Recollect, too, that the Spaniards poetically called the torrent "Rio de las Animas perditas,"—the river of lost souls,—a name the appropriateness of which you will not deny when you are hidden in the inferno of its wild way between dark, overhanging crags that throw sombre shadows over the inky blackness of its eddies where the waters are stopped in mid career by gigantic boulders and permit brief gleams of sunlight to flit across the swift current in lines of serpentine sapphire. No wonder the redskin, the trapper, and the pioneer, each in turn, hesitated, stopped, and chose the most circuitous pathway over the mountain. But to-day the engineer pulls the throttle, and the railway train plunges down the grade, safe and unresisted, into the Cimmerian gloom, to emerge again into the sunlit beauty of the open valley.

Such is western progress. The impossible becomes the commonplace. Climb with me one of those narrow paths which zig-zag yonder mountain slope, and, when you begin to appreciate the fact that you are at an altitude of 2 miles above sea-level, sit you down, and, while you rest, I will suggest something of the patience and pluck which have brought civilization into this mountain-girdled spot.

MINING UNDER DIFFICULTIES.—CLIFFS ABOVE OURAY.



A WINTER SCENE.—BLUE RANGE, NEAR TROUT LAKE.

And first, feast your eyes with the wonderful coloring of the hills. You may have seen the waves of the New Zealand woodland crested with the white manuka; you may have been gladdened by the darker beauty of the Australian bush "when the wattle gold trembles 'twixt shadow and shine"; you may have wandered amid the crimson glories of the tropic jungle, or watched the softer richness of New England maple forests when the autumn has thrown upon them its coat of many colors; but not one of these can equal in superb lavishness of splendid coloring the mountains of Colorado when yellow-haired September has thrown over them the splendors of her red and gold. And in September, too, when the fall rains have been followed by the first frost, the landscape has an atmosphere and the earth a radiant beauty which is more rare than the insipid freshness of early spring.

And then, as you look down into the valley which stretches in noble perspective between the many-buttressed mountains, you begin to realize the fact, previously lost in the immensity of the view, that the rocky covering of these rugged ranges is as full of life as an ant-heap. Far up on the opposite cliffs you see a long line of pack animals descending in single file along a narrow pathway overlooking a ravine into which the sun but rarely penetrates. They are laden with sacks, containing ore. Further down another similar train of burros (or donkeys) comes slowly in the opposite direction. They, too, are laden, but with supplies, among which you would find canned vegetables, iron nails, sacks of flour, dynamite, a pair of blacksmith's bellows, etc. If you were nearer to them, you would wonder at the sure footed, patient little beasts, with a look as demure as a schoolgirl's, and you would be startled by the magnificent polyglot fluency of the driver, whose shouts echo down the cañon and mingle with the unceasing voices of the torrent.

Look down the main valley, and you will distinguish the red roof of a stamp-mill, whose muffled thunder is rendered faint by distance. It is connected by a fairly straight, but dusty, toll-road with the town, whose clustered dwellings you dimly see at the foot of the range. There is also, you will note, another road, connecting the mill with the mine, but it is rarely used now that its winding length of 3 miles is replaced by a straight aërial ropeway connecting the ore-house at the mine with the ore-bin at the mill. Along the tramway, small buckets, each having a capacity of 150 lbs. of ore, are continually coming down full and returning empty. Down the main road a big wagon drawn by six horses is lumbering along, half obscured in golden clouds of dust. And as your eye wanders ahead, you see the regular perspective of telegraph poles, and you become conscious of an even line

RICO, AND THE ENTERPRISE GROUP OF MINES.

SILVERTON, AND KENDAL MOUNTAIN.

NEEDLE MOUNTAINS FROM ANIMAS CAÑON.

which marks the railway grade, and, while you look, a silver wreath of smoke shows the swift rush of the iron horse.

Here is the evolution of the transportation of a mining region from the uncertain burro-trail to the graded wagon road; from the winding road to the direct tramway: from the tramway to the completed railway system, linking the life of the mountain hamlet to the mighty tide of commerce which sweeps across the seas.

In the San Juan this evolution has been accomplished in less than a generation. The men who picked out the first mountain pathway are yet alive; the engineer who built the tramway now directs important industries; and "the pathfinder of the San Juan," as its most successful pioneer has been aptly called, has ceased building toll roads, and become the president of a railroad which his restless energy caused to be constructed.

Something of this story may be briefly told. It begins with the building, in 1867, of a toll road from the San Luis valley westward across Poncha pass. This road was built for the particular purpose of freighting supplies to the gold diggings at California gulch,—afterwards Leadville. It was 110 miles long, and was constructed on a gradient such as a railway might follow, because its projector even at that time had a vague idea that it might prove to be the forerunner of greater things. In 1872 the discoveries made in the country further south led to the commencement of a road from Saguache in the San Luis valley across the range to the Lake fork of the Gunnison (now the site of Lake City), and in 1873–4 this road was continued across another range to Howardsville, the pioneer of the present town of Silverton. This was the first road into the San Juan, and was similarly constructed on a railroad gradient.

In building the road to the Lake fork, the foreman in charge, a man named Enos Hotchkiss, discovered a cropping of ore, and located a claim to which he gave his own name. The Hotchkiss mine had a chequered early history, and was abandoned at intervals until the last 3 years, when, under the name of the Golden Fleece, it was found to contain a body of ore which has made it one of the richest mines in Colorado.

In 1873 rich lodes were found at Ouray. A toll-road was begun from the Lake fork to reach Ouray by way of Indian creek. In 1884 certain gold veins began to be developed on the other side of the Mt. Sneffels range. A wagon-road was constructed from the Uncompaghre to San Miguel, just below the present town of Telluride. In the same year the last-named road was continued over the divide down the Dolores river to Rico.

Each of these toll-roads followed pre-existing Indian trails, and,

ABOUT TO LEAVE OURAY FOR RED MOUNTAIN.

as already stated, in laying them out, there was kept in view the possibility of future railroad construction.* That dim possibility has become a bright reality. Thus, therefore, the untutored mind of the redskin laid down the plan of the railroad system of the San Juan, he in turn following the lines which the frost and the sun, silent sculptors of nature, had hewn out for generations untold.

The building of these roads was no child's play. Often the workers had to be suspended by ropes along the faces of precipitous cliffs while drilling holes for blasting. Even afterwards the hauling of heavy machinery over the mountains was accompanied with much danger. The wagons had to be held back by attaching fine trees to them, or were let down the steep grade with the assistance of rope and tackle. The predicaments into which people got, the mingled danger and amusement, the delays and the accidents which befel the early pioneers, make tales which are as full of quiet humor as of reckless daring.

The commercial aspect of the changed methods of transportation can be suggested by a comparison of the manner in which, at various periods, ore was sent from Silverton to Pueblo.

In 1876 the ore was carried by burro-train to Del Norte and by wagon from there to Pueblo. The cost was $80 per ton.

In 1880 it went by wagon to Alamosa and thence by rail to Pueblo, at a cost of $50 per ton.

In 1881 it was forwarded by wagon to Durango and thence by rail, for $30.

In 1882 the railway took it all the way for $16 per ton. In 1895 the freight rate is $8.00 on low-grade, and $9.00 per ton on higher-grade, ore.

To these notes may be added the statement that it took ten burros or seven mules to carry a ton-weight of ore, that a wagon held from 2 to 4 tons, and that a freight-train is composed of from five to fifty cars, equivalent to a load of from 50 to 500 tons, the minimum figure in the latter case being required only on occasional heavy up grades, and the maximum permitted only on similar down grades. Thus the cost diminished from $80 to $8 per ton, while the quantity transported at one time increased from 2 or 3 tons to 200 or 300 tons.

If such, then, be the kaleidoscopic changes in the picture which portrays a part of the progress of this mining region, would you wonder at tales of extraordinary luck and endless vicissitude which tell the more immediate story of the mines themselves? And yet, believe me,

* Mr. Otto Mears was the builder of these roads. To his early enterprise and energy, and to the later business sagacity of the general manager of the Denver & Rio Grande Railroad, Mr. E. T. Jeffery, the San Juan owes more than this brief note can tell.

BURROS PACKED FOR THE MOUNTAIN CLIMB.

there has been less luck than is supposed, and more good sense, coupled with dogged perseverance; there has been less of wild speculation than you would think and more of skill and enterprise than is told to you in the apocryphal yarns of the hotel lounger.

Take, for instance, the story of the Enterprise mine, at Rico,—a property which has contributed its share of that small amount of gold and silver upon which the shaky superstructure of the world's commerce is built. Rico is across the range from Silverton, and was first visited by the pioneers in 1864, at the time when a guide named Robert Darling brought a party of United States army officers and some Mexicans from Santa Fe to see the cropping of certain lodes which he had found on the Dolores river. In its early days the camp had a very uncertain career, unmarked by important discoveries, until the finding of ore on Newman hill, by Harry Irvin, in 1879, led to the development of the deposits lying at the foot of Mt. Dolores. At first operations were mainly confined to the claims belonging to the Swansea Gold and Silver Mining company. In 1881 a shaft was sunk by David Swickhimer and his two partners upon a claim further north, called the Enterprise. The intention was to sink this shaft so as to intercept the veins which were being at that time so successfully worked in the Swansea ground, it being expected that their extension would be found beneath the drift, consisting of boulders and gravel, which in that part of the hill overlies the surface of the true rock encasing the ore-bearing veins. In 1883 this shaft was abandoned. In March, 1887, Swickhimer resumed the sinking, having become convinced by an examination of his neighbors' mine that the veins which they were successfully working would extend into his ground, and that, unless he soon reached them through his shaft, he would find it difficult to maintain his title to the claim. Many obstacles were encountered; bad luck and want of sufficient experience were added to a heavy inflow of water, which again and again nearly compelled the abandonment of the undertaking. Funds ran out, and the cessation of work seemed imperative; but just at this time Mrs. Swickhimer won $4000 in a lottery, and promptly contributed it to the helping forward of the development of the mine in which she and her husband had a common interest. On the 6th of October rich ore was struck in the shaft at 262 ft. from the surface, the judgment of Mr. Swickhimer was confirmed, and he began a highly successful career. The mine at once became the scene of very active development, and in 1892 was sold for a sum which approximated a million dollars.

This is a tale of logical good sense backed by the same sort of pluck and perseverance that have built the railways across apparently impassable mountain ranges and changed the Great American desert

into the granary of a continent. Instances such as this might be multiplied. It is too often supposed that, because some drunken fool lights by accident on a nugget of gold or stumbles against the outcrop of a silver vein, therefore mining is the sport of a blind and fickle fortune. There is as much luck in mining as in any other business enterprise, hardly more; there is as much room for skill and sense in mining as in other commercial undertakings, and a good deal more. Whenever this is properly realized, the industry will be ranked with agriculture as one of the two most beneficent occupations of a busy humanity.

THE ROYAL GORGE.

THE MODERN RAILROAD MACHINE-SHOP.

By H. D. Gordon.

THE remarkable economies that have been effected in the operation of railroads since their institution, as well as some of the directions in which further reductions can be made, have been ably presented by Mr. L. F. Loree in the papers published in recent numbers of the ENGINEERING MAGAZINE. The subject is very interesting to those who are responsible for the proper and economical management of the various divisions and sub-divisions which constitute the organization of modern railroads.

Among these departments there are none that contribute more to the efficiency, popularity, and profit of railroads than the mechanical department.

It is, of course, true that each is dependent upon the others for a thoroughly successful operation of the whole, but, however perfectly organized and well managed the others may be, if the mechanical department has not properly performed its duties, and the motive power and cars have not been provided or are inefficient, then the business cannot be carried on.

There is no factor of the mechanical department that contributes more largely to its efficiency and economy than well-equipped and well-managed shops.

Mr. Loree says: "By the use of up-to-date tools, and the convenient arrangement of the work and materials, considerable reductions can be made in the cost of repairs. By such means the cost on 170 engines of repairs averaging $926.61 each, at one shop during the past year, was reduced 10½ per cent."

If, then, such economies can be effected by the introduction of modern ideas and appliances in our railroad machine-shops, is it not the duty of those in charge of the mechanical department to give serious attention to the matter of improving the efficiency of their shops by introducing new methods and modern equipment? It is true that previous to the summer of 1893, when the panic first struck the country, much had been done and more was projected in the way of improving shops; but unfortunately during the past two years the universal falling-off in railroad revenues due to hard times and the consequent severe retrenchments has forced the suspension of all improvements not absolutely necessary. Now that the worst appears to have

passed and business is slowly resuming its normal proportions, we are justified in hoping that the necessity for such severe economies will soon be over, and that deferred plans as well as new ones can then be carried out.

That there is much room for improvement in the arrangement and equipment of very many railroad machine-shops in the country admits of no argument. Many of them are carrying on their work in buildings some of which were erected 30 to 40 years ago, and, though enlarged from time to time, have not kept pace with the increase in the amount of work to be done; and it is a rare thing to find a shop in which some portion of the work has not been crowded into the round-house. Many of the tools are as old as the shops, and should long ago have been consigned to the scrap-pile. There seems to be a curious sort of conservatism among master mechanics and shop-foremen that leads many of them to hold on to these old fashioned tools that have served them so well, when instead they should make every proper effort to have them replaced with improved modern tools. Not all the responsibility for this, however, belongs to those in charge of the shops. Master mechanics know too well the difficulty they often have in convincing those in authority that they cannot get along another year with the old tool, which, no matter how well it has been kept, has outlived its usefulness.

There are many railroad machine-shops in the United States to-day where a few thousand dollars wisely expended in the purchase of modern equipment would give as good returns to the road as any investment it could make.

In considering the plans for a new plant, or for extensive additions or alterations to one already existing, the aim should be to have the shop-buildings of ample size for the present needs, to provide for extensions and additions that may be needed in the future, and to place the buildings as compactly as possible, leaving between them only yard-room enough for such material as it may be necessary to store.

If the ground-room allowed is ample, the aim should be to leave such of it as is not occupied by the buildings mainly on the outside of the plant. This, of course, can be used for the various storage-tracks that will be required.

Nothing adds more to the expense of operating shops than the cost of carrying work over long distances and the time consumed by the workmen in passing from shop to shop.

The most bulky parts, such as boilers and tenders, can be kept on the storage-tracks and quickly brought in by a small locomotive when needed; the smaller parts do not require a great deal of room. Especially is this true of shops devoted principally to repairs.

At many shops much old material is kept that has been taken from locomotives which have been cut up; because it is thought that this can be further utilized, it is sometimes kept for years.

While there is a measure of economy in this, it would many times be better to sell the material at once for scrap and put the money into something that could be made of immediate use. Doubtless there is economy in the saving and working-over of old material, but often this is carried to excess, and good judgment is required to know when the limit is passed.

There is much that might be said regarding the design, construction, and material of the various shop-buildings, but these are matters that must be regulated largely by the amount of funds available for the whole work. In general, it may be said that it is poor economy to put up wooden structures for shop purposes. An examination of a large number of the best machine-shop plants will disclose the fact that, while for various reasons there may be differences in construction of buildings and their location with respect to each other, the general designs are conventional; the types may be said to be two in number.

The most common is that where the locomotives are placed in a row side by side on tracks leading from a transfer-table. For shops where the number of engines handled per month will not exceed two or three for heavy repairs and six to eight for light repairs, this is probably as good a plan as any, especially where the same transfer table is utilized for a car-shop which may be opposite. Very few machine-shops so located are provided with facilities for taking down and putting up the work, and in many of them the old plan of "jacking up" is still followed.

Very great economy can be effected by equipping such shops with a drop-table for removing driving-wheels, and with light overhead cranes adapted for quickly handling the parts. Large shops, where many heavy repairs are to be made, and where perhaps new engines are built, undoubtedly should be supplied with modern electric cranes, and I am decidedly of the opinion that the best arrangement for such shops is the long-track plan, placing the engines one ahead of the other in two or more rows, with a center track kept open for bringing in and taking out engines and needed materials.

The old slow-moving rope-driven and "square shaft" cranes are very limited in usefulness, because of their slowness, and for this reason they have never been regarded with favor in railroad shops and locomotive works in the United States; but the introduction of electricity as a motive power has wrought a marvelous change here.

With the long-track plan two single-trolley cranes are required, but, as each handles but one-half the total weight to be lifted, they

can be made much lighter than a heavy double-trolley crane capable of lifting the heaviest engine, and the cost of both cranes should not be much greater than that of the heavy one with its double trolleys. It is seldom necessary to work both cranes together; consequently there are two cranes usually available for the lighter work, and, if they are fitted with auxiliary hoists of 2 or 3 tons' capacity, it will be found that, as savers of time and labor in the operations of an erecting shop, they are invaluable.

With this arrangement, if the work is not extensive enough to require a separate building for boiler-work, a portion of this one can be devoted to it, the cranes being used not only for transferring boilers, but for all the heavier operations.

Although such a building is necessarily high, the overhead machinery needed can be carried on gantrys, which need not interfere seriously with the operations of the cranes.

The old plan of furnishing from one source the motive power for the entire plant and conducting it from shop to shop by shafting, belting, ropes, and other expensive devices is fast becoming obsolete. The demands of the service are so irregular and exacting that it is practically impossible to keep the work evenly divided, and almost daily some part of the machinery must be run overtime.

This has gradually led to the equipment of each shop with a separate engine, thus making it independent of the others.

Objections have been made to this plan because of its greater first cost and the increased expense for maintenance and attendance, but there is no doubt that it is generally the cheapest method if we take into account the amount of power expended in driving shafting, belting, and other machinery that is doing no work and might as well be idle. The adaptability of electricity for this purpose admits of no question at the present time.

Five years ago one might well have hesitated before introducing electric motors for driving lines of shafting or machinery. Anything that was done in this direction was necessarily experimental. To-day one may adopt this method of distributing power with every assurance of satisfactory results. There is no place to which it is better adapted than a railroad shop, and those who may have the planning and installing of the motive power either in a new shop or in one that is being improved will do well to carefully investigate the present status of the question. Electricity is particularly well adapted for lighting railroad shops. After several years' experience with a large plant wholly lighted by electricity, I am prepared to say: "Put no gas-pipes in a new shop," and to further recommend that all old ones be fitted with electric lights as soon as possible, and that *the*

gas be cut off entirely. The large amount of gas-pipe that is required even in shops of moderate size, and the consequent leakage that is constantly going on, is no small item of expense. The light from gas is at best only indifferent, and every one of experience knows that in the short days of winter nothing like a full amount of work can be done during the hours when it is necessary to use gas. On the contrary, with a proper distribution of arc lights for general illumination, and each machine and bench supplied with an incandescent lamp, the work can be carried on as well by night as by day, to say nothing of the fact that the electric light is vastly more satisfactory and healthful to the workmen. The plant once installed, the expense, where care is exercised, is no greater than when gas is used, but rather less.

In selecting the tool equipment it is poor policy to take the cheapest that can be had. There is an old saying among workmen that "anybody can do a good job with good tools, but it takes a good man to do a good job with poor tools." While it is essential that locomotive work should be well fitted up and accurate within reasonable limits, the accuracy and close fitting necessary in the manufacture of machine-tools and the finer grades of general machinery are not here required, and the greater portion of railroad-shop workmen are not, as a rule, apt to be high-grade mechanics. What is needed is that the tools should be heavy and strong as well as convenient and well-built. With such tools properly handled, the cost of machine-trimming and finishing of forgings is considerably less than the smith-shop cost of the same work.

It costs a little more to have a planer fitted with two heads on the cross rail, and still more to have one or two heads on the uprights, but often this more than doubles the capacity of the machine and pays handsomely in the end.

Mr. H. L. Arnold, who has given the subject of the use of milling machines a great deal of attention, said, in a paper entitled "The Economic Possibilities of the Milling Machine," which appeared in the April number of the ENGINEERING MAGAZINE, that "the time is very near at hand when the milling machine, with its multiple-toothed cutter, will take the place in the general engineer's plant which it has already won in thousands of special instances."

Perhaps it is too much to ask that railroad mechanics, who have little time to devote to working up new methods, should take the lead in this matter, but they can at least take advantage of the knowledge that has already been gained, and, if they carefully seek for this and apply it with judgment, the result will certainly be more milling machines and less planers, shapers, and slotting machines and the change will be accompanied with economic results.

As an auxiliary to the smith shop, the cold saw is a valuable machine, and one or more should be included in the equipment of every railroad shop. The amount and character of the work that can be done on these machines would be a surprise to some who are not now acquainted with their useful features. An automatic saw-sharpening machine is absolutely essential to the economic success of the cold-sawing machine.

Excellent light boring mills are now made in sizes that will swing work up to 3 or 4 ft. in diameter and can handle to good advantage a large amount of locomotive work that is now done in large lathes. These mills are made very stiff and strong, and much attention has been paid to the details of speed and feeds. They are made with one or two heads on the cross rail, which may be either plain or turret, and the tables are provided with excellent chucks. The ease with which the work can be got on and off the machine well adapts it to such work as pistons, cylinder-heads, and dome covers, and by its use the cost of machining such parts can be reduced 15 to 30 per cent. and the output increased.

Among other tools not generally found in railroad shops, and the use of which tends to cheapen the cost of production, may be mentioned the turret lathe and the open side shaper of the Richards design. The latter can be used to good advantage for a large class of work that would otherwise require a planer costing twice as much. Most shops use the Fox lathe for finishing their brass fittings, but no large shop can afford to be without one or more turret lathes, for these, with a few special tools, will make a very great reduction in the cost of such work. Many other small parts can also be cheaply produced by these machines.

The tool-room should be a prominent factor in every well-conducted shop. It should contain a full equipment of standard machine-tools of the best makes, and be in charge of a progressive man of ability and judgment. The supply of small tools should be liberal and given out on the check system, which, if properly carried out, insures their being kept in good order and promptly returned.

The many uses to which compressed air can be applied are being thoroughly appreciated by railroad-shop people, and no plant is now complete without its compressor and system of piping. For light work the convenient hoists are invaluable. The cost of fitting out with air-hoists is comparatively small, and the saving in time and labor that can be effected will quickly repay the investment. For large shops a hydraulic plant is now almost a necessity, especially for the heavier operations of flanging and riveting boiler and tank work ; and the time

is not far distant when much forging work will be profitably done by hydraulic machines.

In the smith shop the aim should be to reduce the amount of hand forging by providing a suitable number of hammers and forging-machines, and also by cutting down the amount of finishing work through not forging so close to size and removing the surplus stock with heavy tools in the machine-shop.

Shafting should be run at higher rates of speed; two hundred revolutions per minute is not too fast for machine-shop work. It should be fitted with plain flange couplings and self-oiling bearings. All pulleys on the main lines should be split, and be as light as possible. The wrought-iron or steel-rim pulleys that are now made are well adapted for the work, are both cheap and light, and give excellent satisfaction.

High-speed shafting with pulleys of proper size on countershafts gives high belt speeds and greater horse power with narrow belts. In a plant so fitted, where there are over 12,000 ft. of belting, the widest driving belt is 12 in., and 60 per cent. of the machine belts are not over 4 in. in width.

The piece-work system is coming into more general use each year, and usually with beneficial results. When properly managed, there is nothing that will add more to the output and lessen its cost than this system, but it must be wisely handled to get the best results. Some one has said that the difference between piece-work and day-work is that with the latter the men must be watched, while with piece-work the work must be watched; this expresses the situation. With a proper system of inspection and a wise policy in fixing and maintaining prices, both the men and management will have perfect satisfaction.

The old railroad shops that used to build a few locomotives occasionally, "just to keep the men and tools busy," have found of late years that, considering the prices at which they can now buy, they are no longer justified in building, and principally for the reason that most of the locomotive works have practically rebuilt their plants and renewed their equipment, and have not hesitated to avail themselves of every modern device to cheapen the cost of production, while the shops have not progressed in a like measure. If, then, the former have found it profitable and even necessary to make these heavy expenditures in order to hold their trade, is it not reasonable to suppose that railroad shops could effect at least a measure of this economy in their legitimate work, if they followed more closely the example of those from whom they purchase their power?

A REVIEW OF RAILROAD INVENTION.

By C. P. MacKie.

ADOPTING the conventional allowance for such periods of time, the present year marks the completion of the second generation of railroad life in the United States. The snorting, rickety little "Stourbridge Lion" of 1829 has been replaced by such giant locomotives as those which commanded the world's admiration at the Columbian Exposition; the modest 15 miles or so of the Delaware and Hudson and the Baltimore and Ohio railroads of that year have expanded into the 8000-mile "systems" so familiar to travellers and Wall street operators; the tiny, cramped coaches of the same epoch have been supplanted by the running-hotels of Pullman and Wagner. There are on the 225,000 miles of railroads in this country 36,000 locomotives, 27,000 passenger-coaches, and 1,175,000 freight-cars, to say nothing of many thousands of four- and eight-wheeled odds and ends. These vehicles transported, in 1894, 757,000 tons of freight of all kinds, and 629,000 passengers. They, and the railroads operating them, were served by an army of nearly 900,000 employees. Such being the proportions of our railway traffic at present, as compared with its puny beginnings, it is not inopportune to inquire whether corresponding progress has been made in the essentials of speed, safety, and comfort; nor is it uninteresting to recall to mind the men (too many, unfortunately, already forgotten) who have contributed to make 24 hours passed in a 1000-mile railroad journey today less fatiguing and far safer than the same length of time spent in covering 100 miles 30 years ago.

Few instances of great industrial development present a more orderly sequence of progress from small things to great than does the mechanical history of our railways. There have been but very few sudden and general "revolutions"; it is rather a story of intelligent and, in the sum, successful working-out of competent means to meet evident needs. Unlike nearly every other modern industry, the railroad arts cannot be accused of borrowing anything from China or Egypt. There has been no lack of originality, and that of the highest type; but the growth of railroad equipment and apparatus is more a matter of quick and capable adaptation than of new principles and new elements. Like nature herself, the railroad inventor has not advanced by leaps and bounds, but by slow and patient evolution.

Neither speed, safety, nor comfort is possible in railroad work without a thoroughly good track, and it is only within the last 25 years

that any general effort has been made to secure excellence in this respect. The fundamental elements are older than the use of steam; iron rails (of "snake-head" memory) were in use nearly half a century before the first locomotive jolted over them; flanged iron wheels are but little less aged; sleepers were used in the wooden tramways of the seventeenth century; ballast was contemporaneous with furnace-cinders and gravel-pits; bridges, for purely railroad purposes, were easy to build, after Cæsar's plan, in a country where wood was more plentiful than stone. The strap-rail soon proved its inadequacy, but the invention of the fish-plate in 1844 by Robert Barr was the first step in the direction of a substantial track. The "T" rail, when first brought out by its inventor, R. L. Stevens, in 1830, had a hard fight to win its way against its "double-headed," "bridge," "U," "Barlow," and "bull-head" predecessors and successors; but it did win, and first made heavy engines and fast speed economically possible. Blake, with his rock-crusher, provided the means of securing cheap and abundant stone ballast, and Howe and Fink, with their bridge trusses, had already paved the way for the huge iron and steel viaducts of later days. The locomotive- and car-builders had also made such advances in augmenting the size, weight, and speed of their products that they were, in effect, waiting for better and safer tracks in order to obtain the improved results which their achievements made possible, but it cannot be said that these two branches of railroad development attained anything like equal excellence until after the civil war. In the late sixties and early seventies, however, the maintenance-of-way departments in progressive and carefully-operated roads could truthfully say to the motive-power men: "Come on! we can handle anything you dare put on wheels."

Leaving out of the question, as apart from our immediate subject, the immense advantages secured to railroads by the introduction of steel rails and the greatly increased sections, which were so largely due to the labors of Ashbel Welsh and O. Chanute, the chief factor in the rapid improvement of railroad service which has marked the last quarter century was, necessarily, the locomotive. Fast time, *per se*, was no novelty to either engine-makers or their drivers. Baldwin's first engine, the "Old Ironsides," made, it is said, a record of 62 miles per hour in 1833, only 4 years after the "Stourbridge Lion's" début. Other equally fast, or faster, spurts were common enough in succeeding years; but fast time, as a regular, every-day, matter-of-course incident of the general service, was not practicable with the engines and tracks of earlier years. It would be trespassing too far on the reader's patience to attempt to sketch, even lightly, the myriad steps which have marked the evolution of the leviathans now harnessed

to our express trains. Probably the two contrivances which contributed most immediately to the rapid and enormous development of the American engine were the pivoted truck, first introduced by J. B. Jervis on the Delaware and Hudson railroad in 1831, and the equalizing lever invented by Joseph Harrison of Philadelphia in 1838; for these two improvements gave to our locomotives their most notable characteristics,—flexibility and adjustment to the peculiar conditions of their operation. As far back as 1836 Campbell of Philadelphia built the first eight-wheeler; in 1847 the Norrises of the same city made a ten-wheeler for the Reading railroad; in 1863 Rogers of Paterson turned out the first "Mogul"; in 1866 Mitchell built the first Consolidation; the following year Norris of Lancaster completed the first decapod. And so the record could be prolonged almost indefinitely, until it should become a list of nearly all the master mechanics, motive-power superintendents, and clever shop-men of half the railroads and machine-shops of the country, down to the last few years when we reach the triumphs of the Altoona or Mt. Clare Shops, and of the Baldwin, Schenectady, Brooks, and Rogers Works. None of these giants are the product of one brain or of any combination of brains in the service of one employer; from head-light to buffer, and from truck to smoke stack, they are the outcome of manifold minds, incalculable experience, and highest skill. The best ideas of England, France, Belgium, and Germany have also been adopted, transformed, and utilized, whenever and wherever advantage could be obtained, and the crowning success of one decade has been sent to the scrap-heap in the next by the relentless pressure of competition and progress. In no department of mechanical construction is the pressure more insistent, and in none is the old saw as to one man's meat being another man's poison more aggravatingly applicable. Each road must study its own peculiarities, and each branch of every road's service must have its special requirements met by special means. Hence the apparently infinite variety of locomotive types met in a day's run over busy lines, and the bewildering chaos of detailed invention out of which the stately "Express" and the impudent little "Tanker" alike emerge. The products of 1894 and 1895 are the invention of no man, native or foreign; they are the syntheses of the labors of two generations of practical mechanics, each adding his quota of discovery or adaptation to the mass, and each, whether nameless or famous, entitled to his share of credit for the degree of perfection thus far attained in that Proteus of machines,—the American locomotive.

Given a fast and relatively economical locomotive, it was sure to be laden to its fullest capacity and driven to its utmost limit of practicable speed. Many of our readers will no doubt recall the stuffy,

rickety little boxes in which we used to stew in summer and roast (or freeze, as the weather and the brakeman might determine) in winter, while we fondly imagined we were travelling "first-class." How the wood-cinders did pour through the little 10×12 windows! How the atmosphere grew gamier and gamier, and the aisles dirtier and dirtier, and the seats harder and harder, as we were bounced and jolted and yanked along through an endless cloud of sand and live-coals by day, and live-coals and sand by night! We know a man, now a white-haired, distinguished citizen of this republic, who to this day never catches a whiff from a freshly-roasted peanut without thinking of the old Camden and Amboy railroad. It is not surprising that thoughtful men should early have turned their attention to the preservation of over-strained rolling-stock and the alleviation of human suffering by reducing the wear-and-tear of journeys such as those were. In truth, many of the railroad lines were becoming so long that neither the vehicles or their contents could be counted on to stand the strain for an indefinite time. The passenger profited by both efforts. The first step was to provide something more comfortable for night travel than the abominable car-seats then in use, and in 1836 the Cumberland Valley railroad introduced the use of rude sleeping-cars on its night trains. These were an immense improvement upon the former cramped accommodations. But, at best, their berths were a very poor substitute for a bed. In 1859 Mr. Pullman brought out the first cars furnished with berths and lavatories, wherein could be more or less dimly discerned the progenitor of future Pullmans and Wagners, and in 1864 they were followed by the first true sleeping-cars. The proposal to run such sleepers on all night-trains met a certain amount of opposition from ultra-conservative railroad managers, but the more enterprising and far-seeing took up the idea with energy, and by 1870 most of the railroads of the country had a regular sleeping-car service established. The "parlor car," with its greater independence and increased comfort, was not so generally demanded by the travelling public as was the sleeper; it was more of a luxury. But upon its appearance it quickly became popular, and was followed in 1869, on the Chicago and Alton railroad, by its natural development,—the dining-car. Once a railroad had sleeping-, dining- and parlor-cars running on its trains, with their exclusiveness and higher rates of fare, it was an easy step to hitch a number of them together, without any ordinary coaches at all, and so construct a strictly "limited" train. This was first done in 1872 on the Pennsylvania railroad, and, while not involving "invention" in the patent-office sense of the word, it certainly has contributed vastly to both the comfort and the rapidity with which long trips are made.

The name of Mr. George M. Pullman is so universally associated with all the various classes of this special service that he is generally assumed to be the originator of these several kinds of luxurious cars. Unquestionably Mr. Pullman has shown a greater capacity than any one else for developing the manifold detail of the service, whether in the direction of construction or operation, and in administrative abilities he is distinctly the leader of all who have labored in this field. At the same time the travelling public at large are too much indebted to Wagner and Mann to warrant a neglect of their names in dealing with the evolution of the drawing-room- and sleeping-car. Each of these three designers had novel ideas, peculiar to himself, regarding the ways by which the public comfort could be increased, and experienced travellers find in the cars of each some feature or detail which is lacking in the others. None of them are perfect, but a sleeping-car which should embody the best features of all the systems, and be decorated in the purest style of the best designers taken from the several companies, would come very near to being perfection. Of the several inventions entering particularly into the building of these cars perhaps the two most important are the method of lowering and raising the upper berths and the vestibule-connections. The priority of invention in both these appliances has been disputed, but it is only recording facts, and not expressing an opinion, to note that the suspended upper berth was first used in 1864 by Pullman, and the vestibule in 1886 by the same inventor, although as far back as 1857 a covered way between cars was in use on the Naugatuck railroad in Connecticut.

Scarcely less essential to the passengers' comfort than the sleeping-car and its companions were certain improvements introduced, at approximately the same period, in the construction of passenger-cars of all kinds. Of these the safety-coupler, the use of hot-water and steam-heating apparatus, and the employment of gas for illumination were the principal. The first radical improvement in coupling coaches so as to hold a train solidly together was, in general application, the Miller platform and coupler, which came into somewhat general use in the later sixties, and at once robbed passenger-trains of their last remaining resemblance to a string of coal-hoppers. Of course there have been many other admirable coupling devices, possibly earlier and more meritorious, but it was the "Miller" which inaugurated in a large way the reform in the abolition of the leap-frog style of running trains. In the same way Wm. Martin of Dunkirk is believed to have originated the method, now so general, of heating the train with steam drawn directly from the engine, although there has been the usual patent-wrangle over this idea. W. C. Baker in 1867 brought out his

excellent plan of hot-water circulation in connection with his safety-heater, and did as much as anyone else to establish an equable and wholesome temperature in passenger-coaches. To a German inventor, Mr. Pintsch, we are indebted for the first practical application of illuminating gas to car-lighting, although other good systems have been produced since the introduction of the Pintsch light in 1877. Finally, the gradual improvement in trucks, the invention of the paper wheel by Allen and the borrowing of the large spoked wheels of our English friends, the nice determination of spring resistances, the production of car-seats fitted to the lines of the human body rather than to those of a wooden mannikin, and other similar minor improvements, all contributed sensibly to the attainment of that degree of comfort which has become so habitual to us that we rarely give a thought to the manifold steps by which it was secured.

With increased speed, heavier trains, and more costly equipment arose the obligation—imposed by considerations chiefly of self-interest—to provide reasonably adequate protection for the property and humanity handled by the road. For a long succession of years the safety-appliances of the most advanced railroads consisted of what Whistler would call "an arrangement" in flags and lanterns, with an understudy of bells, cow-catchers, and whistles to supplement it. The manually-operated semaphore was borrowed from the French, *via* England. It originally was, as its name implies, a visual telegraph, and, among other notable feats, signaled throughout France the arrival of Napoleon at Frejus, when that luckless hero started in the campaign which ended at St. Helena. The idea of using this old-time "telegraph" as a railroad signal is credited to Sir Charles Gregory, and, when it was put to this use on the Croydon railroad in England in 1841, it achieved quick success, and was promptly introduced into American practice. Prior to that there were numberless signals (as, in fact, there have been ever since) consisting of balls, disks, odd-shaped pieces of metal or board, etc., intended to inform the engineer of a train as to the condition of main track or sidings, or to control him at stations, crossings, etc. But the first really practical and efficient method of signaling was secured when the "block system" of protection was imported from England. This, with the mechanical improvements made by Saxby & Farmer and the electrical ones added by Sykes, was the origin of most of the really successful signal work done on our railroads. The exceptions are the ingenious and elaborately-perfected system of electro-pneumatic signal control invented by Mr. George Westinghouse and his associates, and the well-planned "disk" or "banjo" signal system invented by the elder Hall. Both of these systems are automatic,—*i. e.*, the approach of the train itself

sets, and its passage releases, them. Both have their advocates, and both have met with much merited success. Besides these very prominent types of signals, there have been produced a host of others, many of them possessing notable merit, but all patterned more or less after English originals. A distinctly novel departure was introduced by Professor Koyl a few years ago, in his "illuminated parabolic blade," whereby a bar of light was projected at night in positions and colors corresponding to those of the semaphore by day. For the present, however, this admirably-conceived invention has, we believe, been withdrawn for further elaboration by its designer.

In securing fast train service, not less important than proper signal protection is the secure and rapid control of switches and other track-interruptions; but, while several highly successful methods are in general use to accomplish this end, they do not, except in detail, differ widely from the best foreign practice. An exception should be made for the original and thoroughly-designed system of switches invented by Mr. Joseph Wharton of Philadelphia, and introduced by him in the early seventies. By this method the main line of rails is left unbroken, and the means of deviating a train is brought under the wheels only when positively required. The advantage of such a plan will be apparent even to the layman who recalls the slight jar felt when passing over switches, however well laid, of the older styles.

We have purposely left to the last what, in the opinion of every unbiased railroad man in our own and foreign countries, is the crowning individual triumph of American railroad invention, and its most distinctively native production,—the Westinghouse air-brake. Dating in its first form from 1868, this apparatus fairly leaped into prominence in the next few years, and, spreading from the locomotive back to the entire passenger-train, soon invaded the freight service, and is now as common on freight-cars as it was on passenger-coaches not many years ago. In the production of this appliance both inventive and technical skill of the highest order was required, and the result was incomparably the greatest contribution to railroad management that has been offered since the first locomotive-wheel was turned by steam. Those who are happily too young to remember the ante-Westinghouse days on our own lines need only recall the behavior of passenger-trains on such foreign roads as may not use the air-brake in order to realize what our present "limited" trains would be, were it not for this invention.

In reviewing the additions made by the second generation of railroad inventors multitudinous inventions of greater or less importance will recur to every practical mind, of which no mention has been possible. All alike are the outcome of study, thought, experience,

and adaptation on the part of men of inventive talent, whose labors we profit by and whose personalities we ignore. Yet they have all played a part, and an important one, in making railroad-travel the pleasure it is to-day, instead of the penance it was 30 years ago.

The lines on which our inventors have to do their future work would seem to be far more clearly defined than ever before. There is no engineering reason why speed of 100 miles an hour should not be maintained on fast trains; the objections are commercial rather than technical. The chief obstacle lies in the ponderous and wasteful mechanisms needed to generate the requisite amount of steam under even the best present methods. The remedy will be found when electrical energy can be generated in a simpler and less expensive manner than hitherto, and signs are not wanting that the inventor is at hand. In passenger-trains not only are too many horse-powers needed to carry each ticket-holder to his destination, but he demands that too many hundred weight of dead material be dragged along with him. Within the walls of his temporary home he is entitled to better ventilation and far better light than he is apt to get, and electricity will provide him with both, as soon as inventors cut loose from old lines of effort. Some benefit has been derived, and much more may reasonably be expected, from the experiments made in introducing steel frames into cars, and otherwise increasing their structural resistance to abnormal shock or accident. Outside of the train, the great desideratum in signal operation—the raising or lowering of the semaphore by directly-applied electrical force—is certain to be attained, if we may judge by the considerable advance already made. In truth, it will not be many years before a train can, and no doubt will, run through its successive blocks by the glare of electric lights, leaving each block in darkness as it enters and lights the next. It is not safe to assume that the railroad inventors of the United States have become extinct, or their art a lost one. What has already been done is but an earnest of what the future holds in reserve. The very fact that the representatives of the great lines now meet constantly, comparing ideas, adopting suggestions, and determining, with all the advantage of aggregated skill and experience, upon the best average types as general standards, is significant in the highest degree. And, after all, in that very coöperation we have an invention which has no peer in railroad history. Who was the inventor of the modern associations it is past the art of investigation to fix with justice, although the name of Albert Fink must ever occur to railroad men in this connection; but none will deny that all interested in railroads, whether passengers or presidents, owe an ever-increasing debt to the minds that first displaced the jarring jealousies of the rival roads by the methods of concord and fraternity.

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THE CAUSES OF RAILROAD ACCIDENTS.

By Julien A. Hall.

RAILROAD accidents in this country cost too many lives and too much money. That the cost can be reduced is a matter beyond doubt. The railroads have it in their hands to protect the lives of their passengers and employees, and they should do it.

Many, perhaps, will ask how this can be done. At first sight the magnificent piece of machinery called the locomotive seems as perfect as science and art can make it; the splendid cars, with every convenience for comfort in riding, eating, and sleeping, seem all that could be wished; but "The World Almanac" says that for the year ending June 30, 1893, the total number of people killed and injured in railroad accidents in the United States was 7346 and 40,393 respectively. Is not this startling, and does it not show that there are weaknesses in our system of railroading that should be cured? But this cure cannot be effected as long as the paying of a dividend at a certain time is looked upon as a matter of first importance.

During the last 20 years the improvements in railroads have been remarkable, but they must be more remarkable in the next 20. When we see crashing past us that enormous mass of iron and wood called the Vestibule Train, we are prone to wonder at the wide difference between the construction of this train and that of a bicycle. A 21½-lb. "safety" will carry a 150-lb. man at nearly the same rate of speed as the train, but for every 150-lb. man the Vestibule Train must carry a dead weight of between 3000 and 4000 lbs. Now, as the bicycle is a practical machine, the train must be unnecessarily heavy; and, if there is such a discrepancy in one important point, may not an equal discrepancy exist in other important points?

I am well aware that the man who undertakes to suggest changes and improvements tending to prevent railroad accidents places himself in a position where he can be sharply criticised by practical railroad men. An unwilling listener can always find in existing conditions a multitude of reasons for maintaining that such suggestions are theoretical or impracticable, because they cannot now be carried out. The world is naturally conservative, and the majority can always be found in opposition to innovation and improvement; but the conservative policy is not always the safest and most profitable in railroad management, and, as a practical man, I maintain that it can serve only a good purpose to review the conditions which make possible the costly and disastrous accidents on American railroads.

To begin with, our roadbed is unstable. Our embankments, instead of being so narrow on top, should be made broader and with longer slopes, and more masonry should be used in connection with their general construction, especially where there is a probability of high water. It is not unusual for a train to be delayed for many hours by a washout, which would never have occurred had the embankment been properly built and protected; such delays are troublesome, expensive, and unnecessary,—avoidable by the use of brains and money.

Excavations should be made very wide and the side-slopes very flat, thereby reducing the probability of slides. All rocks, trees, and stumps close to the edge of the excavation should be removed, in order to prevent them from falling on and obstructing the track. Crossings of tracks should be either above or below grade. Where there are adjacent tracks, the space between them should be sufficient to allow people to stand safely between trains, whether moving or stationary.

Side-tracks should never be located on a grade, making it possible for cars to be blown or pushed off, or run off by gravity. Horrible accidents have been caused by wild cars on the main line.

The track should be completely fenced on each side, from beginning to end, and carefully policed in order to keep off strangers and cattle. Cattle-guards should be of metal and of the most approved pattern, and should be maintained as well as the track.

The time for cheap railroads has passed. When we first began to build railroads in this country, we had to take what we could get; but now it is different. Now we pay our money for safety, comfort, and speed, and we should refuse to have, instead, the possibility of being crushed, burned, or otherwise tortured.

In our bridges we are satisfied with a safety-factor of six or seven; in Europe such structures are three to five times as strong as ours. Our bridges are easily washed away, crushed into scrap iron, or burnt up. Our masonry gets undermined by water, and, unless the danger be discovered in time, perhaps a dozen passengers are drowned. The masonry-supports for our bridges should be placed on firm clay, solid rock, or founded in other suitable manner.

We should avoid wooden trestles and bridges. There is great danger from fire in these structures, and the replacing of them by metal and stone would do away with it. A burning coal dropped on a dry timber will often set it on fire, and will sometimes burn through it, or so weaken it that, unless the damage be discovered in season, an accident will result. We should construct only iron or steel bridges and viaducts, with a large factor of safety; and, when possible, heavy masonry arches should take the place of these structures. They should be regularly inspected by competent men, and not from the rear end of a train.

It is no more reasonable that a navigable waterway should be crossed in a manner to obstruct vessels than that a street or road crossing should be crossed at grade; but drawbridges should not be used, except where it is absolutely impossible to avoid them. Many accidents happen annually on account of drawbridges being improperly open. Fortunately for all concerned, the government takes a hand in the construction of new bridges over streams, and provides that a proper waterway shall be allowed; the demands as to clearance are not excessive. However, another point comes in here,—namely, that vessels should be, as far as possible, so constructed that they will require less head room or that their greatest projections can be folded down. No doubt this will be done when steamboats entirely replace sailing-vessels.

Our railroad track is full of defects. The use of wooden ties is unsafe,—not to mention the wholesale destruction of the forests caused in order to obtain these temporary supports. The rails cannot be securely fastened to them, and the result is that they are easily torn up, spread, or broken. The ties are easily displaced, especially on bridges and trestles, and such structures are so lightly and unsafely built that, when an accident occurs on them, there is but little chance to save trains from destruction.

The spikes supposed to hold the rails to the ties are totally unfit for the purpose. The constant springing, straining, and pounding produced by the wheels work the spikes loose, and I have seen the heads of spike after spike sticking up half an inch above the rail, instead of in contact with it, thus rendering the turning-over of the rail a very easy matter. This state of affairs can be improved. A system of metal track should be devised by which rails would be held rigidly in place, and ties, if used, not easily displaced. By the use of a metal track, the rails can be bolted down and much more effectively secured than by the present system of spikes in wood.

Our rail is too light; often the heaviest is scarcely able to perform the work required of it. It is often made of inferior metal, and carelessly inspected; rail-inspectors should always be able to detect this trouble, but they do not always do it. I have seen all sorts of breaks in rail that had been inspected by a reputable inspector, some of which caused serious accidents. Our rail should be heavier,—not less than 100 lbs. to the yard,—and a system of fastenings should be introduced that would make the joint as strong as any other part. Now we have a weak place at the end of every rail length, and every rail-end is laminated, whether supported or suspended. If several rails were welded together, thus giving much greater lengths than our thirty-feet rails afford, and the joints provided with angle-bars that allow for expansion and make them as strong as any other part of the rail, we

would have a track that would be much safer, more durable, and much less expensive to maintain. The base of our rail should be broader than the height,—say, twice as broad; as such a rail would be more difficult to turn over, greater safety would be secured.

Our present type of locomotive, from its reciprocating action, pounds our track to pieces and limits our speed. There is no good reason why we should not have in its place an electric motor that will not shriek and pop off steam until we are nearly deafened; that will not belch forth cinders and dirt and almost blind us, thereby making railroad travel a worry and vexation of the spirit. We do many things daily because someone else did the same before us.

The defectiveness of our way is one of the chief causes of accident, and, until the weaknesses mentioned, and others, are cured, the number of railroad accidents will continue undiminished. Safety in the operation of a railroad is largely a matter of mechanics, and we should systematize and strengthen our works on common-sense principles; when we do this, many lives and much money will be saved.

Another serious trouble is that our rail is not continuous, being broken in a number of places by switches and frogs. Perhaps only a higher wisdom than ours can tell us how to avoid accidents caused by open switches, as long as these dangerous devices are not eliminated from the track. This should be done, even if the cost of otherwise setting off the cars be more expensive. Let us make our rails absolutely continuous, and transfer cars bodily to adjacent tracks by the use of hoisting machinery. Such devices are used in England,—of course under the control of a block system,—and are found very safe and satisfactory. Particularly should tracks on which very fast trains are run be made continuous, as accidents to such trains are much more serious than those that happen to slow trains.

The track should be straight; where curves cannot be eliminated, they should be made very light. Reduction of curvature is simply a matter of money.

The matter of the elevation of the outer rail in track, on account of centrifugal force, should be studied, and the speeds of all trains over the same track should be made nearly uniform, in order that a rule for this elevation should be of some force, and not a dead letter, as it now is. Attention to this point would prevent many trains from running off the track on the outside of the curve; this generally happens when the speed is what we now consider very high, and therefore the results are more disastrous.

Our gage should be wider. We cannot reasonably expect our high, top-heavy cars to remain on the rails, when they are so close together. Such a widening of the gage would permit the use of cars

of lighter construction, thereby decreasing cost of operation, maintenance, and liability to accident. The dead weight of from 1 to 2 tons per passenger is very excessive.

Cars cannot be much reduced in height, but they can be considerably widened, thereby reducing their liability to overturn. In order to further reduce this liability, the wheels might with a broader gage be placed on the outside of the cars and the body brought closer to the track. This would be much safer than our present high and narrow cars, held on the rails largely by gravity. The present system of constructing cars is bad, as is shown by the fact that, in case of collision, the cars are generally telescoped or crushed. Non-brittle and non-inflammable materials, such as steel, india-rubber, etc., should be used as far as possible in the construction of cars, as such materials give greater strength, durability, lightness, safety, and capacity for high speed.

Our systems of heating and lighting are very dangerous; in case of accident, the cars often take fire, and passengers are roasted. Electricity ought to help us out of this trouble. Generally our sleepers and dining-cars are equipped with many safety appliances that our day-coaches and smoking-cars lack, but those who ride in the last-named cars have lives as well as their more fortunate neighbors in the sleepers, and there is no good reason why they should not enjoy the same safety, if not the same comfort.

This brings to mind another very defective construction to which we trust our lives whenever we travel by rail,—namely, the flanges of the car-wheels, the overhanging shoulder or lip, slightly over an inch square in section, that holds the trains on the track, and is all that stands between us and death or injury when we are travelling in these conveyances. We often hear of a broken wheel causing accidents on railroads, but, considering the demands by railroads for a cheap wheel, and the consequent deterioration of the metal of which the wheel is manufactured, it is surprising that there are not more accidents from this source. A form of wheel and rail should be devised by which almost absolute safety would be provided. The present form of wheel is an astonishing construction, and it is a cause for constant wonder that the violent jerks and thumps to which it is subjected do not break it oftener.

There are one or two plans of rail-guards in use for the purpose of holding a train on a trestle or bridge, in case of derailment, but they are inadequate. On trestles a wooden guard-rail is generally placed, but it is often defective from rottenness or other causes, and is practically worthless. On bridges a guard-rail is used, which might be valuable if the train did not collapse the trusses of the bridge, nine

times out of ten, in lateral displacement on such structures. A strong guard-rail should be devised and securely placed where it will do the most good; and it should be as carefully and as constantly inspected as the other parts of the bridge.

Air-brakes should be used on all freight trains. It is simply barbarous to force human beings to remain on top of freight cars in all sorts of weather and at night, risking life and limb in running over the cars to put on the brakes. Many men annually lose their lives from this cause, are seriously injured, or are ruined in health. The present system of brakes is often insufficient and defective. Hand-brakes are generally not sufficiently strong to slacken the train properly, and air-brakes, improperly applied, will sometimes cause the wheels to cease to revolve and therefore slide, the result being that the wheel flattens by friction with the rail. The wheel then not only makes a very disagreeable clatter, but is rendered dangerous to the rail, its constant impact in cold weather having been known to break a brittle rail and cause a serious wreck.

On many railroads there are old bridges that have not sufficient head-room to pass a train with a brakeman standing on top of it. As long as a brakeman keeps his wits about him and remembers that there is such a defect, he is safe; but let him forget only once, and he is knocked on the head and as surely killed as he would be by a dose of poison. A clear height of not less than 8 ft. should exist between the top of the highest car and the inside top of the lowest bridge.

Another great source of accident is car-coupling. It is not enough for a railroad company to have a car-coupler or brakeman, when he enters its service, sign an agreement that he will not hold it responsible for any accident that happens to him in the performance of his duty; nor is it enough for the company to make a rule that no man shall couple cars with his hand or go between cars while coupling. Men will be careless, whether car-couplers or not, and the railroad company should provide for this trait in human nature by equipping all of its cars with automatic couplers, which are usually safe. There are a great many freight cars in the United States, and to equip them all with some such device would require time; but the railroad companies should be willing to take the time and spend the money in order to protect the lives and limbs of their employees.

The arrangements for guarding the lives of passengers and others, on station-platforms and at car-windows, are very incomplete, except at our largest cities. When a train comes rushing into a crowded way-station, there is very often nothing to keep the people out of its way; many are inattentive and stand too close to the track, and others do not know how close they can stand with safety. Both classes can

be and should be protected. Obstructions, either stationary or moving, should be kept at such a distance from the track that persons leaning from car-windows cannot be struck by them.

All passenger cars should be vestibuled, in order to prevent people from falling from the train when passing from one car to another while the train is in motion. The present vestibules seem very effective, but their mode of construction should be studied with a view to improving them.

Inefficient and careless employees are often the cause of accident. Men are not apt to take vigorous measures for safety, unless they know that danger actually exists. And, when they have neglected some precaution several times and no bad results follow, it is very apt to be regularly neglected, except when there is actual danger known to be at hand. Trainmen have standing orders to approach stations with trains under full control. Some trains have a limited and specified time in which to make a run. Trainmen claim that, in such cases, they could not carry out this and similar orders, and get over the road as expected. In short, they consider such orders impracticable, and they trust to luck.

When working under such impressions, the sense of danger becomes less acute; experience, instead of acting as a teacher to make men more alert, produces generally the opposite effect of leading them to take chances that absolute safety does not allow. Trainmen are not the only employees liable to become careless; there is hardly an employee connected with the work of maintenance of way or operation who does not have some responsibility resting on him, but, in track work, bridge-work, and, most of all, the running of trains, the necessity is great for constant care and watchfulness on the part of every man.

The whole field of railroading is beset with dangers, and, until reforms on the lines indicated are put in force, it will be a hard matter to do the work without injury to the travelling public and employees. On those railroads that show the best record in this respect will be found the most thorough methods of maintenance of way and equipment, and the most consistent systems of operation.

No element of danger is as great as inefficient service, and the best service can only be obtained by employing men who take personal interest and pride in their work. This can be encouraged by making promotions carefully, having in view the filling of places with the men best fitted to do the work.

The American public is quick to appreciate efforts to improve. A general and continued improvement in railroad transportation is demanded by the people. Will the railroads meet the demand?

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ARCHITECTURE & BUILDING

Bricks and Terra Cotta.

A SERIES of valuable articles upon the above-named subject has been running a number of months in *The Builder*, and has now reached the seventeenth number. This deals with bricks, their strength, absorptive powers, density, weights, hardness, etc., which, together, either by their presence or absence in varying degree, constitute the quality of bricks for building, paving, etc.

The limits of strength in bricks vary widely, and this quality, according as it is greater or less, is an index to their other qualities. But either as proof that bricks will resist the pressure to which they will be subjected, or as an indication of other important qualities, the test of crushing strength is less important than other tests, for reasons which follow. "The average brick of commerce, taken at random from amongst its kind, is not a regularly-shaped body. Even where a casual inspection might lead one to suppose that it was, the application of a rough micrometer shows that it would be the merest accident if all its sides and faces were even or relative in length. If measured on the flat, the height of its sides is but rarely found to be truly uniform all the way round. The dies of the machine between which the brick is crushed are, or should be, perfectly parallel to one another. From this it follows that such an irregularly-constituted body as the average brick is incapable of taking the pressure exerted by the machine and distributing it evenly over the surfaces applied to the dies.

"The projecting portions give way before the bulk of the material, the average strength of which is thus lessened, as it is also by the unequal strains produced." The use of soft wood, millboard, lead, etc., for imbedding bricks for crushing tests does not give best results. Of the materials named lead is probably the worst, as it flows under pressure more than any of the others. The best result—that is to say, the most accurate knowledge of the resistance which brick will oppose to crushing force—is obtained by the use of plaster of Paris, according to the method proposed by Professor Unwin, in which the brick to be tested is made substantially the core of a true parallelopipedon, the plaster supplying all defects in form. "No machine hitherto invented possesses strength enough to crush pieces of sufficient magnitude to invest the results with the importance they should have from a practical point of view. The only occasions an architect would be seriously called upon to calculate the strength of piers of brickwork, or, rather, the load they would safely carry, would be in the erection of a very large building, or in positions where they would be subjected to the pressure of heavy machinery, or of a large quantity of ironwork; and these are precisely the occasions on which feeble results of the crushing machine on very small piers (carefully made for crushing) would be of but little service. For the rest, the load that the smaller piers would carry should be sufficiently well known, from the experience of their more frequent use, to obviate the necessity for experiment on the subject."

The test for porosity is regarded as "the best all-round test to which bricks can be subjected. At first it might seem that it is the easiest of all the tests, but experience will soon show this to be a mistake. It is now generally recognized that there is an intimate relationship subsisting between the crushing strength of building stones, their specific gravity, and the relative amount of water they absorb; but, except in a limited sense, the same cannot be said for bricks and terra-cotta. The vitreous film produced on many kinds of bricks, whether distinctly visible, or only ascertainable on a micro-examination, is mainly responsible for the difference in this respect between bricks and stone; while local vitrification interiorly also impairs uniformity of re-

sults. Leaving that on one side, and looking at the matter in its broader aspects, it may at once be noted that a weak brick will usually absorb a great quantity of water, but it does not follow that a strong brick will not do likewise. Many bricks imbibe a large proportion of water, but will transmit hardly any; whilst others, equally absorbent, allow most of it to pass through. This is a property that does not appear to have hitherto formed the subject of direct experiment. Perhaps the best way to investigate it is to inclose the upper part of the brick in an impervious vessel, so that the former constitutes the base of the latter. The vessel is then filled with water to a definite height, when the column will sink as the brick allows the water to pass through. A graduated scale in the vessel and a time piece is all that is then required to register the rate of percolation. Care should be taken to thoroughly saturate the brick before commencing to read the scale, and, of course, it should be carefully set with as little cement as possible (which should also be tested), and so fixed that the water can pass through the brick only, and not through the cement as well."

The distinction here made between transmission and absorption appears to open a new lead in the investigation of the qualities of bricks from different sources. The capillarity of bricks has an important bearing upon dampness of walls. The usual methods of testing for capillarity—to wit, immersion wholly in water, or immersion leaving only one face exposed—may be extended with advantage to the determination of homogeneousness. "For this, break the brick in halves, and placing one half in half an inch of water as before (not on edge), observe the manner in which the moisture-line rises on the broken surface of the brick. If it rises in a tolerably straight line, the brick is fairly homogeneous; if, on the other hand (as is most frequently the case), that line is curved or irregular, it shows that one part of the brick is more absorbent than another. The deleterious effects produced by hard lumps in the material are well brought out by this method, especially if the water be chemic ed." This last is a very reliable and elegant method for the purpose intended. The topics of density, specific gravity, weight, and hardness are reserved for a future number of this series.

Tests of Building Stones.

A PAPER read by Mr. Lea McI. Gaguer, Ph. D., on Feb. 20, before the American Society of American Engineers, and printed in the *Transactions* (No. 3, vol. xxxiii, March), contains an account of a series of careful investigations to develop the relation between two methods of testing building stone,—to wit, frost tests, and sulphate-of-soda efflorescence tests. The recent establishment of artificial storage warerooms has afforded increased facilities for conducting frost-tests, and a comparison between the results of the two methods can now be readily instituted. The paper contains a preliminary enumeration of experiments performed both by freezing and by the sulphate-of-soda method, before entering upon the description of the special tests brought before the society. This list, and the foot-notes referring to the publications wherein they are described, form a considerable bibliography of the subject. The process employed in the special tests described was that of Brard as modified by d'Hericart and de Thury. (*Chateau. Tech., du Bâtiment, Vol. I, p. 272.*)

"A saturated cold solution of pure sulphate of soda (Glauber salt) was used, great stress being laid by de Thury on the solution being saturated cold. Experiments made by the French inspector-general of quarries have demonstrated the fact that stones which will resist frost and the action of cold saturated solution of lye are entirely broken up by the action of a hot saturated solution. Experiments made by Dr. Valté, of the School of Mines, on concentration of soda solutions developed the following fact: when getting a hot saturated solution of this salt, the temperature of the solution will rise above 212° F. (100° C.), and will keep going up until finally it passes what may be called the 'critical temperature,' when decomposition will take place, S_2O (sulphur dioxid) be-

ing driven off and Na$_2$SO$_4$ (caustic soda) being left behind, which may have the solvent action of an alkali on the silicates in the rocks. Decomposition will apparently also take place in the case of the limestones. The normal cold saturated solution of sulphate of soda is of course neutral. Former investigations all demonstrate the necessity of using a cold saturated solution."

The specimens, fourteen in number, comprising the different kinds of stones commonly used in building, such as marble, limestone, granite, gneiss, trap, sandstone, and brick, were "carefully prepared, brushed, dried, and weighed," and "were boiled in the sulphate of soda for half an hour, in order to get complete saturation. At the end of the half hour, it was noticed in every case that the solution was slightly alkaline, although at the start it had been neutral. In order to prevent any continued chemical action, the beakers were emptied, the specimens rapidly washed with water, and the beakers immediately refilled with the neutral sulphate solution. After soaking for several hours, the specimens were hung by threads, and left for 12 hours (during the night) in a dark room.

"In the morning all the specimens were covered with an efflorescence of the white sulphate of soda crystals; they were then allowed to soak in the solution during the day, and again hung up at night. Effloresecing for about 12 hours and soaking for about the same time constituted a period. The experiments lasted for eight periods, and were conducted in this way in order to make them correspond with those with freezing water, as in the cold storage room the specimens could only be changed night and morning." The temperature of the cold room was from 4° to 10° F. (—16° C. to —12° C.), and the specimens were left to thaw and soak during the day in a room with the temperature at about 85° F. (30° C.) After the completion of the tests the specimens were allowed to soak in water for as long as it took to remove all traces of sulphate of soda in the other series of experiments, after which they were carefully dried and weighed. During the progress of these experiments the deterioration was so slight that the effect was scarcely noticeable, the sandstones only showing the effect by a slight residue in the bottom of the pails in which the experiments were made. The results are given in tabular form." These show that, except in the case of the sandstone specimens, notably decomposed sandstones, the losses were small, and that they were less by the frost test than by the efflorescence test.

In the discussion—several members taking part—Mr. L. Le Coppet Berg, speaking as an architect, stated among other things that "it was customary with his profession to select a stone on account of its beautiful color, or because it harmonizes with its surroundings, or on account of a desired finish which it will readily take,—first, of course, making as sure as possible, by the opinions of experts, that the stone will weather well. When the stones are built in, every precaution is taken to get them of even quality, on their natural bed, etc., and yet after one winter's exposure, frequently, certain stones will begin to show discolorations, and, as year after year goes by, will deteriorate more and more, until, after 7 or 8 years, they are almost entirely disintegrated, although most of the neighboring stones are perhaps still perfect." He therefore wished to ask the author if there was any simple practical test, which could be applied at the building, to find out whether two stones of apparently the same quality were actually so.

In closing the discussion Mr. Luquer replied that he did not think such a test could be devised. He further stated that tests made by Mr. Gerber, by both of the methods compared, and communicated to the society at the same meeting, "corroborated very closely the results obtained in his own series of experiments, and emphasized the fact of the undoubted stronger action of the sulphate of soda."

Architectural Aberrations.

WHEN in this department of our February number we criticised the architectural incongruities embodied in the design of the "Cairo" apartment house, in Washington, which had been indiscrimi-

nately praised by a contemporary, we were not so fortunate in finding a name for this sort of work as *The Architectural Record* for May and June has been. "Architectural Aberrations" is the title of a series of papers now running in the magazine named; and in No. XIII. of this series the Cairo building is thus ranged under an already large category. With the public offensiveness of many buildings like the Cairo, this series is dealing without fear or favor. "There is a patent absurdity in taking thought and spending vast sums of money for the purpose of making a harmonious city, and then permitting any promiscuous private person who can get possession of a piece of ground, and raise money enough to put a building on it, to nullify all your dispositions and vulgarize your town." And of the "Cairo" in particular it is said that a stranger visiting Washington not long ago might have thought, "here is a town that is at least secure from the sky-scraper. He might have said this even a year ago, when he would still have been confident that no vandal would put up an example of the Chicago construction in Washington, because the intelligent vandal would be convinced that, where land was so abundant and expansion of area so easy, the sky-scraper would not pay. Alas! he can say so no longer. A vandal has been convinced that the sky-scraper would pay, and, being unrestrained by statute or propriety, has carried this revolting notion into execution. The result is the *Cairo*, the present aberration. 'A ten-story building in a ten-acre lot' is necessarily an architectural aberration; and a twelve-story building in a city of magnificent distances is a contradiction in terms. It does not so much matter what kind of a building it is. The owner might have employed an artistic architect, and the architect might have produced as admirable a building as the Dakotah in New York—distinctly the most successful of the lofty apartment houses. The owner would still be a public malefactor, and the architect an accomplice in a public offence which is not punishable by law only because we are too imperfectly civilized to punish public offences of the esthetic kind. Our ears and noses are the objects of judicial solicitude, but not our eyes. A man may not establish a soap-boiling establishment, or a slaughter-house, or a boiler-shop, in a quiet residential quarter, but he may put up a sky-scraper and none can say him nay. We whip the devil around the stump, when a man raises a stench or a clatter, by pretending that it is dangerous to health, which is mostly bosh, both as to the soap-factory and the boiler-shop; but, when he constructs any eye-sore, we can do nothing except relieve our feelings in print, as in the present instance." . . . Granted—what no reasonable or humane person will ever grant—the propriety or necessity of a sky-scraper in Washington, what kind of sky-scraper is the Cairo? It is the worst kind. There is only one malefactor concerned in the designing of it, for the owner, it seems, is also the architect. That is satisfactory, for one likes to think ill of as few fellow-creatures as possible. It would be more satisfactory if there were any evidence that the owner had applied to artistic architects to help him gild his pill, and they had particularly refused to abet him and left him to bear the odium alone. But there is no real reason to think so well of the practitioners of architecture. They are too apt to say with the owner, *il faut manger*, and the answer is equally obvious and familiar in each case. At any rate the pill is ungilded. The building is a box, and the combined owner and architect has done nothing to mitigate its boxiness. . . . It is a box full of holes. . . . It is curious how the effect of boxiness, inherent in the original parallelopiped, is enhanced by all the things the architect has put on it ostensibly to relieve it of that appearance. The balconies at the angles at the centre, and between the two, are merely box-like troughs, and so is the cornice a mere projecting box. It almost seems as if the designer must have projected these boxes in a cynical spirit, as if, instead of trying to mitigate the boxiness of the building, he were intent upon aggravating it and 'rubbing it in.' Upon the whole, we decidedly prefer the side, where he has not

pretended to do any architecture, to the front, where he has made his unsuccessful pretensions in that direction. The side is an ugly object, a very ugly object, but it makes no pretensions, and thus escapes vulgarity. It is the pretension of being an architectural work that makes the front so exasperating, when it is, as evidently as the side, a box." In conclusion, it is a "shameful fact that there has been no way found of preventing the erection of the Cairo in the capital of the United States."

Use and Abuse of Marble.

A DISCUSSION upon the use and abuse of marble for decorative purposes, which occupied an evening at a recent meeting of the Institute of Architects, is reported in *The Architect and Contract Reporter* (April 26). The discussion was opened by Professor Atchinson, who said the objection to the use of flowered marble for columns that bear weight was its liability to flaws and defects. Such shafts, before being placed, ought to be tested for strength by the hydraulic press.

"With regard to the internal use of marble in England, it looked and felt cold in winter, and, when buildings were not warmed, it condensed the damp. Marbles mainly formed of carbonate of lime were useless externally, as the polish rapidly perished. The use of marble for decoration was to color harmoniously by means of a particularly beautiful and specially-colored material. The finer-flowered sorts had in their coloring every sort of motive and caprice that could astonish and charm." The professor then described the colors of different marbles, and referred to the imperishable colored decorations to be obtained by inlaying. "Monumental color was as hard to get as monumental form. The safest course was to adhere to one color, or to some strong contrast of two colors, such as black and white, or dark green and white. Black and white for columns, balustrades, and walls had a dignified effect, but the white should greatly predominate, or the effect would be too funereal. If an effect of richness, magnificence, or gorgeousness, or of delicacy or loveliness, were required, the same rules held good in marble as in painting. For a white or a light ground, with color interspersed, the other colors should be very light, or bright colors in small pieces; while for a dark or low-toned ground white or very light tones should be sparingly used." The successful use of colored marbles for decorative effects require what Professor Atchinson regards as "a rare gift,"—the "natural ability to harmonize colors perfected by study, observation, and practice."

Mr. William Young followed in the discussion, and spoke of the now largely-increasing use of marble for English interiors, and intimated that much of this work was faulty. He thought the true use of marble meant something more than merely lining walls with slabs of that material, set in courses marked off by horizontal and vertical joints after the manner of the marble wall-papers with which the walls of the passage and stairs of every ordinary house used to be covered. In marble, as in other materials, the architect should follow a certain order and scheme to bring out his design. The labor of the hewer, the sawer, and the polisher revealed the beauties of marble; thought and skill must be added to make it beautiful in architecture. To explain his meaning, the author referred to the arrangement of the marbles represented in Mr. Alma-Tadema's picture, "The Roman Bath." For use in a large way, marbles should be few, but well chosen. With three or four different marbles, handled by a master, there was nothing within the range of architectural art, from simplicity to magnificence, that the architect could not accomplish. In selecting marbles for columns, arches, &c., it was sometimes exceedingly difficult to get the particular type wanted to insure perfect harmony. Instances within the author's own experience were cited. Columns should be constructive, and not planted on for decoration; if possible, they should be monoliths. Square pillars should be solid marble, and not brick-cased with marble slabs jointed to imitate solid masonry. The marble on walls, where solid blocks would be useless waste, should be so treated as to show that it was

lining. Ordinary box-marble chimney-pieces, consisting of slabs of marble placed one in front and one on each side, as though to give the appearance of a solid block, the author considered not to be true use of marble, and not architecture. With regard to the question, "Should Color Follow Form?" the author was of the opinion that there was much sound truth in Mr. Ruskin's dictum that color should be visibly independent of form, although in actual work it was found that color, as a rule, must follow form. There were, however, exceptions.

Wind Pressure.

THE discussion of wind pressure and its effects upon structures of various forms is active. Scarcely have we laid down one publication in which the debate has been opened before we take up another which continues it upon a different, if not an original, line. The question will doubtless at some time in the near future be settled experimentally,—the only method by which it can ever be authoritatively settled. In fact, experiments already performed have gone far toward settling it. They show that under certain conditions wind pressure—that is to say, unbalanced wind pressure—may far exceed what was only a few years ago considered the maximum.

Indian Engineering (April 13) says that, far "from being a question whose interest is mainly theoretical, many accidents which have occurred to large roofs are directly attributable to the extraordinary negligence often shown by failure to apply known facts to some particular case under consideration. The mistake does not consist in a wrong estimate of the total resultant thrust on any building or roof due to wind pressure against one side of it. The usually accepted formulæ will give with sufficient accuracy the total horizontal pressure against a structure exposed to wind of a given velocity; it is the distribution of pressure over different parts of the structure concerning which there is so much popular misapprehension."

"When the average newspaper reader sees an account of some roof being blown off by the wind, his idea probably is that the wind got underneath it somehow and lifted it up. *The Engineer* will scarcely share this opinion, but, nevertheless, his roof's design will very probably indicate as little knowledge of the subject as would be argued by such a belief."

The pressure of a moving fluid against any obstacle which it surmounts and passes is but partially composed of the direct pressure due to the impact of the fluid against its exposed face. A large portion of the total—often by far the greater portion—is represented by a negative pressure on its sheltered side, due to rarefaction of the fluid to leeward. Noticeable when we observe a heavy and incompressible fluid, such as water, this is particularly marked in the case of a highly elastic and extensible fluid, such as air. An article by Irminger in the *Ingenipren*, Copenhagen, detailing experiments made on the subject, is very valuable as giving quantitative results which enable the general principle to be readily applied to actual cases; and from it we see how much more considerable than is commonly supposed is this complex character of wind pressure.

These experiments made by Irminger, referred to in the quotation, have shown quite conclusively that the shapes of structures independently of their projected areas facing the direction of the wind have much to do with the effects of wind upon them.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Architecture and Building in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

*30997. Architectural Aberrations.—The Cairo. Ill. (Arch Rec-April-June.) 1800 w.

*31620. The Architecture of Railroad Stations. Ill. Bradford L. Gilbert (Eng Mag-July.) 3000 w.

*31632. The Use and Abuse of Marble for Decorative Purposes (*Arch*-April 26.) 1200 w.

31664. A New Reducing Instrument for Perspective. Ill. Alfredo Melani (Am Arch-May 11.) 2000 w.

We supply copies of these articles. See introductory.

*31668. Door Decoration. Ill. H. Leslie Ramsey (*Plumb & Dec*-May.) 600 w.

*31669. Mural Decoration. Maurice Greeley (*Plumb & Dec*-May.) 1200 w.

31710. Artistic Decoration.—The Treatment of Modern Residences and First Class Buildings (Bos Jour Com-May 11.) 900 w.

*31734. House Building Hints (*Ill Car & Build*-May 3.) 1500 w.

†31758. Wind Pressure. Editorial (*Ind Engng*-April 13.) 900 w.

31800. Novel Foundations of the Marquette Building. Ill. From Carpentry & Building (Ir Age-May 16.) 600 w.

31836. The New Tenement House Law. Editorial (Arch & Build-May 18.) 1500 w.

31912. Sound in Its Relation to Buildings. H. W. Burrows (Am Arch-May 18.) 11000 w.

31959—$1.50. Wind Bracing in High Buildings. Guy B. Waite, with Discussion (Am Soc Civ Eng-March.) 17500 w.

31960.—$1.50. The Relative Effects of Frost and the Sulphate of Soda Efflorescence Tests of Building Stones. Lea McI. Luquer, with Discussion (Am Soc Civ Eng-March.) 8000 w.

†32061. Municipal Building Laws. Dankmar Adler (In Arch-May.) 4000 w.

†32062. Soap and Water in Relation to Architecture. P. B. Wight (In Arch-May.) 800 w.

32066. Foundations for Tall Buildings.—The Problem That Had to be Solved to Secure Stable Ones (Bos Jour Com-May 25.) 1100 w.

*32076. Slow Burning Buildings. William McDevitt (Arch Build & Dec-Feb.) 900 w.

*32077. Terra Cotta. Anon. (Arch Build & Dec-Feb.) 1100 w.

*32079. Points in Acoustics. David Gunn Baxter (Arch Build & Dec-March) 1700 w.

*32102. Exhibition by the Electric Fireproofing Company.—Deductions. F. E. Cabot (Br Build-May.) 1300 w.

*32103. Why Do They Crack? Ill. Will I. Nott (Br Build-May.) 1300 w.

†32154. The New Public Library in Boston. Ill. I. Its Artistic Aspects. Mrs. Schuyler Van Rensselaer. II. Its Ideals and Working Conditions. Lindsay Swift (Cent Mag-June.) 6500 w.

*32174. Some Sussex Churches. H. Goodall Quartermain (*Brit Arch*-May 24.) 3200 w.

†32233. Brickwork and Masonry in Ancient Times in India. J. D. M. B. (*Ind Engng*-May 4.) 3000 w.

32239. The Deterioration of Modern Workmanship.—Failure of a Conference Called to Discuss the Matter (Am Arch-June 1.) 3000 w.

32314.—75 cts. The Colonial Style of Architecture. William Danmar (Tech Quar-Dec.) 2000 w.

*32364. The Influence of Architectural Style upon Design. Ill. Walter Crane, with Discussion (*Builder*-June 1.) 1000 w.

*32365. Lindisfarne Priory. Ill. Charles C. Hodges (*Builder*-June 1.) 3000 w.

Serials.

12568. Building Construction and Superintendence. F. E. Kidder (Arch & Build-Began May 6, 1893—42 parts to date—15 cts. each).

18737. The Engineering of Architectural and Building Construction. Ill. William H. Burr (Eng Rec-Began June 6, 1894—11 parts to date—15 cts. each).

19713. Brick and Marble in the Middle Ages. Ill. G. Edmund Street (Br Build—Began Jan., 1894—17 parts to date—30 cts. each).

20419. Modern Methods of House Painting. A. Ashmun Kelly (*Plumb & Dec*-Began March, 1894—15 parts to date—30 cts. each).

21288. Theatres. Ill. E. A. E. Woodrow (Am Arch-Began April 14, 1894—16 parts to date—15 cts. each).

21736. The Art of Building Among the Romans. Ill. Auguste Choisy. Translated by Arthur J. Dillon (Br Build-Began April, 1894—13 parts to date—30 cts. each).

26069. Modern Steel Fireproof Construction. Ill. F. M. Small (Arch & Build-Began Oct. 13, 1894—7 parts to date—15 cts. each).

26967. Stained Glass and Fret Lead Windows, etc. W. J. Eden Crane (*Ill Car & Build*-Began Nov. 9, 1894—9 parts to date—30 cts. each).

27036. The Basilica and Its Adaptation to Modern City Churches. Ill. George Ashdown Audsley (Arch & Build-Began Nov. 24, 1894—7 parts to date—15 cts. each).

28494. Bricks and Terra Cotta (*Builder*-Began Jan. 5—19 parts to date—30 cts. each).

29253. The Guilds of the Medieval Workers in Stone. Edward C. Weaver (Stone-Began Feb.—4 parts to date—30 cts. each).

29578 On the Use of Brick in Domestic Architecture. Ill. Ralph Adams Crane (Br. Build-Began Feb.—2 parts to date—30 cts. each).

31085. Notes on the Polychromatic Decoration of Churches. George Ashdown Audsley (Arch and Build-Began April 20—3 parts to date—15 cts. each).

31319. The Modern Office Building. J. Hollis Wells (Br Build-Began April—ended May—2 parts—30 cts. each).

31688. Painting, and Its Relation to Architecture. C. W. Whall (*Builder*-Began May 4—ended May 11—2 parts—30 cts. each).

31880. Practical Masonry and Stone-Cutting. Fred T. Hodgson (Stone-Began May—1 part to date—30 cts.)

31911. The So-Called Colonial Architecture of the United States. Ill. O. Z. Cewin (Am Arch-Began May 18—3 parts to date—15 cts. each).

32100. Terra Cotta or Stone. Thomas Cusack (Br Build-Began May—1 part to date—30 cts).

32206. The Blackpool Tower. Ill. (*Engng*-Began May 24—1 part to date—30 cts).

32261. A New Departure in Engineering. Ill. (Eng Rev-Began May 20—1 part to date—30 cts).

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal."

The Late Arthur Mellen Wellington.

IN the death of Mr. Arthur Mellen Wellington, late editor of *The Engineering News*, the profession of civil engineering and the country at large have sustained a severe loss. As one of the heads of an influential engineering journal he was best known to the general public, and in this position his exceptional talents as an engineer, a writer, and an editor have done perhaps as much as those of any one who could be named for the advancement of the profession and the dissemination of sound principles. These efforts were directed, not only to the improvement of general practice, but also to elevation of the ethics of the profession.

Advance proofs containing a well-prepared biographical sketch of Mr. Wellington were forwarded to us by *The Engineering News*, arriving too late to be available for our June number. We are, however, glad to assist in honoring the memory of a man so worthy of honor, and herewith present the outlines of a life wholly worthy of emulation.

It is not given to many men to leave so many "footprints on the sands of time" as Mr. Wellington did. His life was one of ceaseless activity, and, when the blows of his hammer fell, an impression was always made.

"Arthur Mellen Wellington was born in Waltham, Mass., December 20, 1847. He was descended on his father's side from an old New England family, which had resided on a rocky hillside farm in the town of Lexington, Mass., since colonial times. In physique he was the very opposite of the typical Yankee, having a sturdy, well-proportioned frame; but his nervous temperament and his never-failing store of energy well indicated his New England ancestry. He graduated at the Boston Latin School, and then, when only 16 years old, began the study of civil engineering in the old-fashioned way" as an articled apprentice in the office of John B. Henck, of Boston, the author of Henck's Field-Book.

"He found time to pay some attention to mechanical engineering, and he passed an examination for a position as assistant engineer in the navy, but was not appointed on account of the ending of the war." His first engagement was in the engineering corps of the Brooklyn Park Department, under Mr. Frederick Law Olmsted, as leveler and assistant engineer. In 1868 he obtained his first position in railway work, on the Blue Ridge R. R. in South Carolina, as transitman, having charge of a locating party. He then went to the Dutchess and Columbia R. R., in New York, as an assistant engineer. When he was 23 years of age, he was placed in charge of a division on the Buffalo, New York, and Philadelphia railroad, and was soon advanced to the position of principal assistant. After 2½ years, he became locating engineer of the Michigan Midland railroad, and later was engineer-in-charge of the Toledo, Canada Southern, and Detroit railroad.

"Mr. Wellington's first literary venture was made in 1874. It was in 'The Computation of Earthwork from Diagrams,' a book which was the outcome of the methods he had worked out for expediting his own computations in the works in which he was engaged. This book was very favorably received. . . . His great work,—that by which his fame as an engineer was firmly established,—'The Economic Theory of the Location of Railways,' was begun in 1875, and was first published in the *Railroad Gazette* in the latter part of 1876, as a series of articles on 'The Justifiable Expenditure for Improving the Alignment of Railways.' These articles were reprinted in book form in 1877, and the attention of engineers and railway men was at once attracted to their writer as an engineer of uncommon brilliancy and ability."

A long list of subsequent practical and

literary work filled the interval between 1877 and 1884, in which year Mr. Wellington took a place on the editorial staff of the *Railway Gazette*. Some of this work called Mr. Wellington to Mexico, where he spent 3 years previous to his engagement on the staff of the *Gazette*. During his term of service on this publication Mr. Wellington did much of the best kind of literary and professional work. The engagement was discontinued in January, 1887, Mr. Wellington becoming part owner and one of the editors-in-chief of *The Engineering News*. The influence of his energy and ability was at once seen in every department of this journal. Within two years its subscription list had more than doubled, and the paper had become a recognized authority in departments which it had theretofore hardly essayed to touch. In his editorial work he combined in wonderful measure the two valuable qualities of originality and industry.

"Of the work which engrossed the last 2 years of his active life we may not speak fully at this time; but, as the record of his life would be incomplete without it, we cannot pass it wholly by. In the summer of 1892 he took a vacation of 3 weeks, but, instead of leaving the city, as was his usual custom, he devoted his leisure to working out some ideas in thermodynamics which had occurred to him years before. The result of his study was the invention of an entirely new type of thermodynamic engine, designed to convert heat into mechanical work with a much smaller percentage of loss than the best existing steam engines.

"In his labors upon this latest child of his brain, his eagerness was such that he was no longer able to turn his thoughts away from it, even in the few hours which he allowed himself for rest; and there were nights when the dawning of morning found him still busy at his desk. Even his iron constitution could not bear up under such strain, and early in 1894 he found himself physically unable to go on with his work."

From this time Mr. Wellington never regained his health. "On April 25, at a consultation of physicians, it was decided that an operation for the removal of a diseased kidney was necessary, and it was performed on May 15 with success. But, besides the disease at this point, there was a chronic weakness of the heart, and at 9.30 P. M. on May 16 the organ refused to perform its work."

In all that go to make up an admirable man Mr. Wellington was richly endowed. A splendid physique, a powerful mind, a cheerful, happy disposition, fidelity to friends, sterling principles,—all these were his; and the regrets of all who knew him have followed him to his final resting-place.

Cement Testing.

THIS subject never loses interest with engineers. So many anomalies manifest themselves in the behavior of cements; there is yet so much to know about them; their qualities—including all their tricks and manners—are so intimately related to the permanency of the most important engineering constructions,—that no more vital question exists in the whole line of civil engineering than cement testing. The assurance that his materials are all right is most anxiously sought by the trained and experienced engineer. On his own ability he can rely; experience has taught him self-confidence; but the materials—unless he can make sure of *them*, he stands on slippery places; and of all the materials he has to use cements are the most likely to fail him at some time and in some place.

One of the best papers on this subject which it has been our fortune to meet with was read before the Canadian Society of Civil Engineering by Mr. Cecil B. Smith, and printed serially in *The Canadian Engineer*,—the first part in the May number. The persistent and continual investigation of this inexhaustible mine, and the disagreement of investigators, are spoken of as illustrating how little the subject is understood, and the failure, up to the present, to solve all the intricate mazes of the problem. The paper is a long one, and in it is compressed a mass of important and curious facts. A large portion of it is devoted to a tabulated statement of results of tests of Canadian, English, and Belgian Port-

land cements, which were carried out in 1893-94 by a committee of the society.

The points of interest which impress the reader at the first perusal are the proposed mode of conducting tests, and some anomalous behavior met with in some of the samples tested. We will indicate herein some of the leading points, with the preliminary statement that the remarks made upon each, which we must for the most part omit, go far to substantiate the propositions made by the author. The average specific gravity of Canadian Portlands is given as 3.11; of English, 3.10; of Belgian, 3.055. The average specific gravity of all Portlands is 3.09. It is therefore advised to specify, as a minimum for Portland cement, a specific gravity of 3.10.

"The water required for standard consistency is considered by many to be very important, but many tests have been demonstrated to the writer that what is especially needed is that there shall be sufficient to make good briquettes; to err, say 1 per cent., in adding water is fatal, if too little, while, if too much, it does not seem to affect the strength of briquettes at 1 week, certainly not at 4 weeks. This is contrary to statements often made regarding the increased strength given by a minimum amount of water; but probably what is referred to is an excess of water sufficient to make a thin batter soup. Undoubtedly such an amount not only makes the briquettes shrink and crack in drying, but will seriously affect the early strength.

"A very peculiar effect was met with in two Canadian Portlands and one English. They were evidently fresh, and, when mixed with a normal amount of water, would work into a good plastic mass, but in about one to two minutes after the water was added, they would suddenly set so hard that it was useless to attempt to put them in the moulds. By increasing the per cent. of water to about 30, a thin batter was made, which could be got into the moulds before this action took place; of course this amount of water made the set very slow, and deadened the indurating action in one-week tests. When tests were made on these cements several weeks later, this effect had disappeared; perhaps some one connected with this industry can explain the cause of this action."

In residues or fineness the variation is enormous. On a No. 80 sieve there remained only 2.7 per cent. of one, while of another there remained 52.2 per cent. On a No. 50 sieve there remained of one sample 0.25 per cent., while of another sample 31.4 per cent. was left. On a No. 120 sieve, of one sample the residue was 6.7 per cent., while of a compared sample the residue was 61.20 per cent. English Portlands are generally coarse; selected Canadians are, on the contrary, fine. The author urges the severest requirements for fineness.

"The time of incipient and final set, as found by Gilmore's needles, does not seem to affect the strength, except for short tests. While the slow-setting cements are generally stronger, good cements may be either slow-setting or quick-setting; but ordinarily, unless for tidal work, a slow-setting cement has the desirable features of allowing masons to mix and use good-sized batches of mortar without constant tempering, as practised with quick-setting ones, much to their hurt.

"The blowing test advised by Faija has detected a 'blowey' tendency in several instances; but much late evidence seems to throw some discredit on blowing tests, whether made with hot or boiling water, on the ground that manufacturers can, by the addition of sulphate of lime, cause the cement to be so slow-setting and set so strongly as to resist the blowing tendency of so much as 3 per cent. of free lime added after the cement has been burnt. If this is a fact, chemical analysis will need to be resorted to more frequently to detect this dangerous adulteration, which is fatal in sea water, and bad in any case, as the great strength which it gives to cement at early dates is apt to decrease at longer periods. Belgian No. 19 cement, tested, gave higher results at 1 week than at 4 weeks; this looks a little suspicious."

Cement should be tested when in the same condition as that in which it is to be used. The present German method is to use mixtures of 3 to 1, and this is approved. Great difficulty is experienced in getting anything like uniformity in sand-tests.

"The variation in putting the mortar in the moulds has been so much more than the variation in the cementing value of the cement that the tests were valueless, so that most testers have clung to neat tests as being simple and a fairer index of cementing qualities. This view is in fault, and misleading."

As a result of the tests made by the committee (Mr. Smith is a member of this committee), 20 per cent. of water is regarded as "just sufficient to make a plastic mortar, so that a good briquette can be formed, while more water tends to drown the cement and make it weaker at both the 1-week and 4-week tests, although longer tests would probably show a recovery in this respect. This proportion of water applies to 1 to 1 and 3 to 1 mixtures, and will probably be about right for 2 to 1."

"It is conclusive that, if any standard test under light pressure is to be adopted for sand tests, 20 per cent. of water must be prescribed as a definite part of the test, and in this way perfect uniformity obtained. It is understood that the sand used is standard sand, dry and sharp; a finer or rounder sand would allow less water to be used. This amount of water, while greater than that usually given by authorities whose method of making sand briquettes is by some severe hammering process (German), is still close to the amount used in practice." The object is to "approach as nearly as possible to actual usage, and fortunately the two conditions are in harmony with each other." The pressure adopted in the tests was 20 lbs. per sq. in.

Failure of the Manchester Ship-Canal Enterprise.

UNDER the title "The Beginning of the End," *The Railway Times* (May 4) editorially reviews the embarrassments which have fallen upon the Manchester ship-canal enterprise. The lesson is a hard one to the Manchester rate-payers. It will be remembered that the project completing the canal at the expense of the rate-payers was accepted with enthusiasm by these willing victims, notwithstanding the fact that they were warned by *The Railway Times* and other papers that it was "a dangerous new departure in finance."

In 1891, under the title "Manchester Martyrs," the paper quoted said: "It is satisfactory to note that the Manchester corporation does not wish to make money out of the necessities of the canal company. 'A strong feeling exists,' says the committee, 'that the arrangement should preclude the possibility of any profit accruing to the corporation in any event, and we believe that this may be practically attained.' We venture to think that the corporation will find but little difficulty in avoiding a profit on its ship-canal speculation."

Now it says that "events have moved rapidly since 1891. The canal has been carried to completion, or to something approaching completion. It has been opened for traffic throughout its whole length by her majesty, the queen; and the traffic receipts have been what we always predicted they would be,—miserably inadequate to the pretentious magnitude of the undertaking. It will occasion no surprise to readers of *The Railway Times* to hear that the company is about to ask the Manchester city council to forego the interest on the £5,000,000 sterling of public money which have been sunk in the canal. Necessity is a stern taskmaster, and, although the canal company may go through the polite form of asking the city to forego its interest for a time, probably most of the city fathers whose municipal patriotism has brought Manchester into such an unpleasant predicament have realized ere now that the interest must be foregone, whether the city likes it or not. 'It is ill taking the breeks off a Hielandman,' says the Scottish proverb, and certes it were as profitable to attempt to draw blood from a stone as to extract money from the Manchester Ship-Canal Company. It may be asked, however, whether foreclosure is not likely to prove more profitable to the city than the temporary waiver of its right to interest on the money lent. We shrewdly doubt it. The loss of £5,000,000 is a very dismal business, but the assumption by the city of Manchester of complete control of the canal would infallibly

mean throwing good money after bad. Where funds can be raised by the simple expedient of a small addition to the rates, there would always be the temptation to further expenditures, and probably it would be cheaper to write the £5,000,000 off as a bad debt than to saddle the municipality with the endless expense and responsibility of so vast an enterprise. It must be interesting to the unfortunate shareholders to read that a representative of the French government has been surveying their property with a view to the improvement of the navigation of the lower Seine. If Johnny Crapaud could only be persuaded to buy the canal right out at a reasonable price and transplant it bodily to France, he would confer a boon upon the suffering shareholders, and materially improve the health of Lancashire. Meanwhile the rate-payers of Manchester are in the untoward position of having advanced £5,000,000 sterling on a security not worth foreclosure. Notwithstanding the greatness of their services to the undertaking, they are only third mortgagees for £1,359,000 of first debentures,—repayable, by the way, at par, on January 1 next, —and £600,000 of second debentures rank in front of their bonds." It seems truly pitiful that an enterprise so vaunted as this has been in the past, and which, from an engineering point of view, is of so much interest, should thus have become a target for the shafts of satire. The effects of the failure will be hard enough for those to bear who must suffer from them, and these are, presumably, not alone the Manchester rate-payers.

Improved Tent Flap and Lock.

ANYTHING which claims to add to the comfort and convenience of engineers in field-work that necessitates camping out —often for weeks and months—is sure to attract the attention of the entire profession, provided that, *prima facie*, it shows some merit. Such a device, it appears to us, is one illustrated herewith, and described in *Engineering News* (May 9). It is an improved tent flap and fastening recently invented by Mr. Jas. J. Rinn. By means of these devices, which are stated to have been patented, the entrance flaps of tents may be tightly closed against both wind and rain, and also against meddlesome or intrusive people.

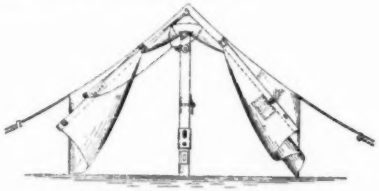


FIG. 1. FRONT VIEW OF RINN TENT.

"A rigid strip is fastened in the edge of one or both of the entrance flaps, and means are provided for securing these strips to the tent-pole, as indicated in Fig. 1. Either one flap or both can be converted into doors, as required. The strips are connected to the upper end of the tent-pole by a universal, yet detachable, joint (Fig. 2), in such manner that the strip and its flap can be swung aside, merely providing an entrance; or both strips can be detached from the tent-pole and a wide opening made, as shown in Fig. 1. The horizontal slit in the canvas required for this purpose is opened or closed by cords provided, and a hood closes this opening against wind and rain.

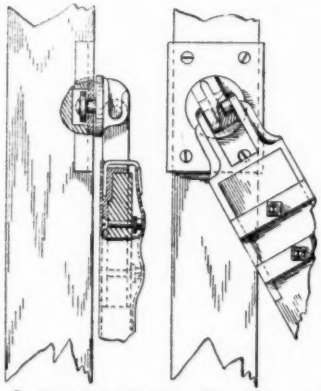


Fig. 2. Connection Between Tent-Pole and Rigid Piece in Tent Flap.

"To fasten the tent, a mortised bolt is firmly secured on the rigid strip at about the height of a door-latch, and to the front of the tent-pole is fastened a locking or latching device. In the side of the lock

is a push-button, always accessible from the inside and reached from the outside by inserting the finger in a slit provided in the canvas. The insertion of a pin into this lock makes it secure against entrance from without, and, by using a padlock on a hasp, the rigid strip can be locked to the tent-pole when the owners of the tent are absent.

"Similar means are provided for securing the tent when both flaps are to be used as doors. These appliances may be adapted to both ends of the tent, and by an ingenious arrangement Mr. Rinn provides for the use of mosquito- or fly-nets in connection with these doors."

These devices also obviate the beating and wearing of tent flaps which occur in windy weather. Very little weight is added to the outfit, and the strips are readily detached from the pockets and lashed to the tent-pole when getting into marching order. A modification of the devices adapts them to round tents and to those which have no tent-pole at the entrance. Mr. Rinn some time ago exhibited these tent appliances to us, and we were favorably impressed with them, having personally experienced some of the annoyances they are intended to obviate.

The "Jumbo."

A NEW device, if in these days of rapid progress anything invented 10 years ago can be called new, is described in *Louisiana Planter* under the title "Irrigation by Wind Power in the West." *Scientific American*, May 18, has reprinted this article. "There is in the west a vast, nearly level plain, with not a wind break from the north pole to the gulf, with but little wood or coal, with considerable, but not sufficient, rainfall, with fertile soil, and a necessity for elevating the water for irrigation. Clearly there is need there for a cheap, simple, effective invention for elevating water. Everywhere in Western Kansas may be seen windmills of primitive form, horizontal, vertical, or vertical-geared. Holland has 12,000 windmills, which average 8 h. p., used to drain the polders. The States of the plains will soon apparently have more than that number used to irrigate the prairies. Steam pumps, gas engines, hydraulic rams and pumps driven by animal power, and all of the known devices for elevating water, are now finding experimental tests in Kansas. It is probable that valuable data in regard to comparative cost and efficiency of these different motors will be obtained from these tests."

"A crude invention, which is called the 'Jumbo' wind engine, appeared in Western Kansas about 10 years ago, and is now coming into extensive use; its ease of construction, economy in cost, capacity in power, and simplicity, seem to recommend it to those who observe its work. It resembles the paddle wheel of a stern-wheel boat, with a shaft 12 or 14 ft. long, with a diameter of 12 or 16 ft., with six or eight radial arms. The lower half of this horizontal wheel is shielded from the wind, so that the air acts only upon the upper vanes. A crank upon one end of the shaft connects with a pump. Its power can be indefinitely increased at any time by increasing its length, which can be done by anyone who is handy with tools. It is said that a 'Jumbo' giving 100 h. p. in a 15-mile wind can be put up at cost of $500. The wind acts upon this sort of paddle-wheel from all points of the compass except two. It seems to require no 'governor,' but simply pumps more during the storm. No tower is required, and it is placed so that the radial arms will be clear of the ground. In fact, in Kansas, where there are few trees and no hills, it is claimed that the wind currents have greater force at the surface than high in air. Perhaps in this crude device for raising water for irrigation in a wind-swept country there is the germ of an idea which, when fully developed and perfected, may become widely useful. If so, it will be quickly improved, for it is watched by many eager and anxious eyes, and now the development of an implement requires days where formerly centuries were needed. The crude 'Jumbo' of to day may become the perfected irrigating machine of to-morrow in level and treeless sections."

The above contains all that is pertinent

to the subject named in the title. The article is a curious jumble of talk about bicycles, ancient methods of raising water, overshot water wheels, etc.

A CONCRETE bridge, having a clear span of 164 feet and 26 feet wide, was recently constructed over the Danube at Munderkingen, in Austria. Blocks of this kind have shown the remarkable resistance of 187 tons per sq. ft. in 7 days, 235 tons in 28 days, and 308 tons in 5 months.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Civil Engineering in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

Bridges.

31937. Notes on Rivet Holes and Sheared Edges in Steel, with Editorial (R'y Rev–May 18.) 2800 w.

31958.—$1 50. The Bridge Over the Tennessee River at Johnsonville, Tennessee. Ill. Hunter McDonald, with Discussion (Am Soc Civ Eng–March.) 6300 w.

31985. The Pivot Pier of the Third Avenue Bridge Over the Harlem. Ill. (R R Gaz–May 24.) 1100 w.

31992. Brooklyn Bridge Terminal Station. Ill. (St R'y Gaz–May 18.) 1000 w.

32307. Painting Iron Railway Bridges. Walter G. Berg (Eng News–June 6.) 8500 w.

Canals, Rivers and Harbors.

*31656. The Utilization of the Severn. Editorial (*Eng*–May 3.) 2900 w.

31704. Proposed Canal from the St. Lawrence to the Hudson. Ill. (Can Eng–May.) 1200 w.

*31746. The Beginning of the End. Editorial on the Manchester Ship Canal (*R'y Times*–May 4.) 600 w.

*31914. The Chicago-Sanitary District Canal—Description of the Work and the Methods of Construction on the Brighton Division. Ill. Alex E. Kastl (Jour Asso Eng Soc–April.) 5400 w.

*31951. River Improvement Works. Charles David Marx (Chau–June.) 5800 w.

*32037. The Baltic Canal. Anon. (*Ill Car and Build*–May 17.) 1000 w.

32063. Chicago's Great Canal (Fire and Water–May 25.) 1100 w.

†32221. The Nicaragua Canal. G. W. Sherwood (Jour Fr Inst–June.) 5000 w.

32288. The New European Ship Canals (Ir Age–June 6.) 1300 w.

*32334. The North-East Sea Canal (*Engng*–May 31.) 5000 w.

Hydraulics.

*31649. Failure of the Bouzey Dam. Ill. (*Engng*–May 3.) 1000 w.

*31651. Air Vessels for Rising Mains. Ill. Bernhard A. Smith (*Engng*–May 3.) 1800 w.

Irrigation.

31807. Irrigation by Wind. From La. Planter (Sci Am–May 18.) 1300 w.

*32124. The Future of the Great West. E. V. Smalley (Forum–June.) 4000 w.

*32352. Masonry in Tropical Irrigation Work. Editorial (*Eng*–May 31.) 1300 w.

Miscellany.

31645. Locked Tents for Engineers and Surveyors. Ill. Patent of J. J. Rinn (Eng News–May 9.) 450 w.

31811. The Collapse of St. Catherine's Tunnel. Ill. (Sci Am Sup–May 18.) 600 w.

31831. Standard Connections for Rolled Beams. Ill. Henry S. Richard (Eng News–May 16.) 1200 w.

31970. The Comparative Adhesive and Cohesive Strength of Cement. Ill. Louis J. Affelder and Robert C. Brown (Eng News–May 23.) 900 w.

31975. Manufacture of Rock Wall Plaster. Ill. (Sci Am Sup–May 25.) 750 w.

31986. A Graphical Method of Studying Questions of Haul of Earthwork—The Mass Diagram. Ill. C. Frank Allen (R R Gaz–May 24.) 1000 w.

*32201. A Rapid Method of Approximation to Earthwork Quantities. A. H. Shield (*Eng*–May 24.) 300 w.

*32235. Water Jet Pile-Driving. Ill. James F. Hobart (Am Eng & R R Jour–June.) 1500 w.

32305. An Experimental Study of Field Methods Which Will Insure Stadia Measurements of Greatly Increased Accuracy. Ill. Leonard Sewal Smith (Eng News–June 6.) 4200 w.

*32340. The Royal Indian Engineering College, Cooper's Hill. Editorial (*Engng*–May 31.) 2000 w.

Serials.

28498. Thames Bridges. Ill. (*Engng*–Began Jan. 4—13 parts to date—30 cts. each).

31702. Cement Testing. Cecil B. Smith (Can Eng–Began May—1 part to date—15 cts).

31759. Notes on Reservoirs. C. B. Target (*Ind Engng*–Began April 13—2 parts to date—45 cts. each).

31829. The Chicago Main Drainage Channel. Ill. (Eng News–Began May 16—3 parts to date—15 cts. each).

31871. Glasgow Harbor Tunnel (*Engng*–Began May 10—2 parts to date—30 cts. each).

We supply copies of these articles. See introductory.

DOMESTIC ENGINEERING

Ventilation in New York.

IN *Heating and Ventilation* for May Mr. Fred P. Smith repeats an allegation which he made in the February number of the same publication,—to wit, that the methods of ventilation employed in New York "are crude, and the results below those secured in other localities." This allegation certainly challenged proof to the contrary, but Mr. Smith says that up to date none has been received, though his statements have been denied:

"Among the buildings I spoke of were two of special importance, buildings representative of the best it was believed money could purchase,—namely, the Metropolitan Opera House and Carnegie Music Hall. Of the first named I stated—without other evidence, I must admit, than that of breathing the air within the building during the performance—that 'the ventilation was less than required by law in Massachusetts for a six-room school,' and that 'for filthiness the air could not be beaten in the tenement districts.'

"To be sure, these are strong statements; they ought not to be true statements; but they were when made, and they are now. The first apparent result of the article was to rouse the well-known engineer who planned the original system to a sense of personal injury and a demand for retraction, this being followed by an examination on his part, showing how his work had been destroyed and his plans rendered well-nigh useless. Of course he, being an engineer of the right class, quickly receded from his demand. . . The building was erected in 1882-3, and in it was a system of heating and ventilation designed, and, I think, installed, by Mr. Frederic Tudor; There was then provided a fan, said to be capable of delivering 70,000 cu. ft. of air per minute, and the entire plant showed evidence of most careful attention to every detail; there were numerous inlet openings, including some three hundred beneath the orchestra chairs. There were also large registers, or grilles, which allowed air to flow out to the attic and thence, through louvres, to the atmosphere. Much of the work then done, or, rather, of the system then planned, would now be considered crude, but ten years ago was in line with the best thought. If the original system were the present one, my criticism would have to be modified somewhat, for it would about fill one-half the Massachusetts measure, or give a supply of about 15 cu. ft. per minute instead of 30 cu. ft. per person."

Mr. Konrad Meier, one of Mr. Smith's critics, is in error, "for that system is not now in the building, and no substitute has been provided." Mr. Smith says further that "at the very time Konrad Meier was so sure I was wrong in my criticism, the Opera-House directors were holding meetings and receiving proposals for correcting the defects, or at least affording some relief."

When, after the fire that destroyed the original building, the present building was erected, "the ventilation was done in just about the average fashion of the New York talent, which means that it was not cared for at all." Mr. Smith then computes how much air at the maximum can be delivered into the auditorium, even at the questionable velocity of 12 ft. per second, and finds it to be only 15,000 ft. per minute, or about one-fourth the amount stated by Mr. Meier. Besides, there is no exhaust system equal to the supply, as the Massachusetts law requires. The basement is also used as a plenum chamber, which Mr. Smith regards as a serious fault. His argument upon this point deserves consideration, since the ventilation of a great many buildings comprises this feature. "Were it [the basement] used to exhaust vitiated air from above, then it could be put to its natural uses without hindrance; all the odors complained of would be removed with the foul air, and much better results would be secured."

"I wish to assert very positively that the use of the basement for a plenum supply room, common as it is, endorsed and used though it is by eminent engineers, is wrong in principle, as well as very difficult and expensive in practice. The turning of theater floors into pepper-box affairs, with a lot of holes through chair legs or covered with mushroom caps, is as far from right as one can get. I must, in fairness, state that, when the fan has been in operation for 15 minutes, the air in the basement is perfectly sweet and wholesome, all the odors and filth having been blown into the opera house for the benefit of the audience."

"Authorities agree pretty well that, when the air is so vitiated by breathing as to show, on analysis, over ten parts carbon dioxid in ten thousand parts, it becomes a poison, harmful to the system. The exhalations from the lungs of four thousand five hundred persons render 135,000 cu. ft. of air impure to a harmful extent every minute. When ventilation is so deficient as in the Metropolitan Opera House, the air will become vitiated in a half hour. At the end of an hour it is bad, and begins to cause headache and drowsiness. At the end of two hours it reaches a condition of positive disgusting impurity, and before the end of the last act it is literally true that it cannot be beaten for filthiness in the tenement districts. It is with a gasp of relief that the carriages are sought and fresh air is found once more."

In conclusion it is alleged that "the perforation of floors with finely-divided inlets for fresh air is bad engineering, not only from the practical, but the theoretical, view. The space beneath the floors should be used for the foul air exhaust rather than fresh-air supply. The withdrawal of air from near, or at, the ceilings removes the fresh, rather than the foul, air more than three-fourths of the time the rooms are used. Of Carnegie Music Hall I made no criticism except 'insufficient supply,' but commended the system. The engineer who planned it stands at the head of the profession, and only good work could be expected from him. Still he would make great improvements in the methods there employed were he to plan it after four years' study, which have elapsed since its completion."

Hospital Ventilation.

AN example of cooling air for hospital ventilation by reversing the function of heating coils is described in the *American Architect* (May 4), in a paper reprinted from the *Proceedings of the American Academy of Arts and Sciences*. Dr. Morill Wyman gives an account of the experiment, which was begun in the spring of 1893. The coils first used were the hot-water heating coils used during the winter for heating air before admission to the wards. Water from 57° to 58° F. was available for cooling at the time the experiment was begun.

"On the first of May, 1893, all windows and openings in the air-chamber were carefully closed, and the water from the main let on. At 3 P. M. the external thermometer was at 84° F.; there was no wind, and the patients were suffering from the heat. The temperature of the air-chamber was 67° F.; the water as it entered the cooling boxes, 57-58°. The electric fan, 36 in. in diameter, driving the air into the air-chamber, was put in motion, making five hundred revolutions with an air-moving power of 10,200 cu. ft. a minute. At 4 P. M., the air entering the ward at the registers was at 71° F. During this hour 400,000 cu. ft. of air, as measured by a Cassella's air-meter, were thrown into the ward through the ten registers: a quantity sufficient to fill the ward of 21,000 cu. ft. twenty times an hour,—once in 3 minutes.

"The result was satisfactory; the comfort of the patients was manifestly improved. But it must be observed that the cooling-surfaces were, first, the ten cooling-boxes, of 30 sq. ft. each, at 57-58° F., and, secondly, the floor and the walls of the air-chamber, the two together amounting to about 3300 sq. ft. The temperature of these walls could not well be determined; but, as they had not been exposed to much increase of heat since the winter, they may be assumed to have been about that of the water-supply,—then 58° (in

winter it is about 50°). At the outset, then, we had the air-chamber full of cool air and a cooling surface of about 3000 ft., along which the air, driven by the fan, was diffused before it entered the ward. The cooling power of the boxes may be assumed to be about one-tenth that of the walls." Subsequently, during the summer months, the temperature of the water rising, and the quantity needed entailing too much expense, the use of the coils for cooling was abandoned, but the same amount of ventilation was maintained by forcing the air into the ward by the same route, and the comfort thus afforded to patients was "immediate and decided." This result is attributed correctly to the increase of evaporation from the skin caused by the large volume of air circulated,—400,000 ft., per hour for sixteen patients,—"and yet, while this large quantity was passing through the ward, it was only known, except at the registers, by the accompanying sense of freshness and pleasant coolness. It was never felt as a draught." Without going further into the details of these experiments, we may say that the results led Dr. Wyman to the conclusions: "first, that fresh air directly from the open, in the quantity and manner there applied, can be made to give great comfort to the sick during the heats of summer; and, secondly, that previous cooling of the air so supplied is difficult and practically useless. To this may be added—what is of much importance to charity hospitals—that the method here adopted is the least expensive of the cooling processes hitherto made generally known."

The coils were only a little more than one-eighth the capacity they ought to have been to reduce 400,000 cu. ft., of air from 90° F. to 70° F. With cooling water at say 65° F., and with water at 70° F., the surface would have needed to be infinitely increased to effect such a result. If water could be obtained at about 54° the season through, as is sometimes, though rarely, the case with water from artesian wells, coils could be used with sufficient effect to cool a ward of this size, containing sixteen patients, and materially lower the temperature below the outside temperature; but to cool such a volume as was attempted in this case, even with water of this temperature, would require some six or seven times the cooling surface used in the experiment. Of course, the cooling in this attempt was "difficult and practically useless," as stated by Dr. Wyman. It does not seem possible that the cooling of air by bringing it into contact with surfaces cooled by evaporation of water was unknown to the hospital authorities, or that they did not know that the use of ice to cool water circulated through the coils would have been cheaper than the use of such a large volume of water taken from the city mains. Besides this, more efficient cooling would have lessened very much the volume of air needed to afford comfort to patients, and thus have reduced the cost of current for the fan. The use of ice would have entailed only a very moderate cost after the installment of a cheap apparatus for applying it.

Prehistoric Sanitation.

ARCHÆOLOGICAL research every day reveals the fact that modern progress, upon which we justly congratulate ourselves, had its prototype in past ages. The interest of a *conversazione* at Manchester, England, was much heightened (*British Architect*, April 26) by an address of Professor Boyd Dawkins, in which he sketched the progress made in sanitation by ancient people, the evidences of which are not written in books, but found only in the relics of the past. The beginnings were traced back even to the paleolithic age. The paleolithic man "had a fixed habitation," and he "invariably chose dry areas as areas of habitation. In the neolithic man we had the first evidence of a public, for they lived as a community. But even this people had nothing of the nature of sanitary knowledge. They left their refuse in their habitations, and they were ignorant of water-supply. With regard to their habitations, however, they presented us with several sanitary hints. They always selected those spots where there was natural drainage; and, with regard to ventilation, they had perhaps too much of it."

At the close of the bronze age, with the

acquisition of iron, and, naturally, with the use of this material for implements, there were important developments in sanitary appliances. In certain camps which have been explored by General Pitt Rivers, particularly in one near Lewes, there has been found the most elaborate system of refuse-heaps. There were, however, in this age no evidences of any artificial water-supply. But neither in the neolithic, the bronze, or the pre-historic iron age were there any interments allowed within the area of habitation; and in that particular we can look back as far as those times for an example of a reform which is needed in some parts of the country. Evidence that in the bronze age cremation was the rule has been found in the limestone ranges of Derbyshire, and on the undulating surface of the chalk downs of Wiltshire.

Prof. Dawkins even went so far as to intimate that modern sanitary conferences might learn something from the ancient Romans. In the first place, Roman buildings were all more or less rectangular, and it is important to bear in mind that there was no jerry-building in those times. Their mortar was laid on hot, and not allowed to get rotten first, as is the case with us, and their cementing material was so strong and durable that it remains to-day, while a great many of the stones it cemented have disappeared into dust. Their water-supply was admirable. "Then, in the matter of drainage, they had a most perfect system of breaking the continuity of the drain inside and outside the house." The Roman excavations at Silchester show a most elaborate and perfect system of arterial drainage; and something like 1700 years ago, in the south of England, they were sufficiently advanced in sanitary matters to do very much the same sort of thing that Manchester is now attempting to do in sending her sewage by a system of arterial drains down to the lower waters of the Mersey. Their water-supply was exceedingly well organized, and, whenever they could bring a supply through the city or a villa, they did so. They sank wells sometimes to the depth of 100 ft., and they were well acquainted with the artificial methods of obtaining water. Their method of heating their dwellings was the most perfect that could be devised, consisting of a heating chamber in the basement from which a vast number of flues radiated through the dwelling.

Heating in Engineering Hall, University of Illinois.

THE arrangement of indirect radiators in the heating plant of this building is believed by Prof. L. P. Beckrenridge, chair of mechanical engineering, to be new. A description of it is given by him in *The Technograph*, published by the engineering societies of the university. Results of a series of tests of efficiency of the radiator surface are also given in tabulated form. A description of tests of temperatures in various parts of the building, and of the changes of position that were decided upon as the result of these tests, is also comprised in the paper, which is a good study in designing and constructing heating plants.

The system is what would be generally styled partly direct and partly direct-indirect. But, with reference to the piping, what is known as the Mills overhead system has been employed. The number of square feet of radiating surface is: direct (including pipes), 7559; indirect, 3159; or a total of 10,642 sq. ft.; and the ratio of heating surface to cubic feet of space heated is 1 to 77.

"The steam which is delivered into the sub-basement of the building at about 40 lbs. pressure is passed through an 8-in. Davis reducing pressure valve, and the pressure reduced to 1, 2, 3, 4, or 5 lbs., as the external temperature demands. For 3 weeks of this winter (1894-5) the temperature was down to zero nearly every night, and, on the occasion of one of the tests, was 22° below. During the severe weather the building was easily warmed with 5 lbs. of steam. With the temperature between 10° and 32°, above 3 lbs. is sufficient to warm the building, while for warmer weather 1 to 1.5 is all that is required.

"The steam, after passing the reducing valve, is carried through an 8 in. main to the attic of the building, where it divides into three equal branches 4.5 in. in diameter,

and is thus distributed to the three wings of the building. The overhead mains in the attic are covered with asbestos fireproof covering. From the mains run the smaller mains to the sides of the building, and then drop to the sub-basement in one straight run. From these drop-pipes connections are taken, one to each radiator. Liberal provision is made for expansion of all pipes and connections.

"Nearly all the direct radiators are connected to the drop-pipes by a tee in the pipe near the ceiling of the room below; while the indirects are connected mostly by tees in the pipe at the floor-line of the room in which the radiators are placed.

"The indirect radiators are in all cases placed under the windows, and in a recess left for them in the brickwork. The air-supply comes through openings in the cast-iron plate, which forms the lintel of the window below, passing up to the radiator through a space left for it in the wall.

Air is induced to flow through those radiators by ventilating shafts distributed throughout the building.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Domestic Engineering in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

Heating and Ventilation.

†31491. Test of a Heating System. L. P. Breckenridge (Tech-No. 9.) 2000 w.

31700. The Hogan Vertical Water Tube Boiler.—Erected at the State Homœopathic Hospital for the Insane, Middletown, N. Y. Ill. (Am Mfr & Ir Wrld-May 10.) 600 w.

31838. Theoretical Velocity in Circulating Pipes.—Hot Water Heating. Ill. R. C. Carpenter (Met Worker-May 18.) 1200 w.

31844. Heating of the Hotel Stafford, Baltimore. Ill. (Eng Rec-May 18.) 1800 w.

*31860. Electrical Heating. D. H. Dowsing (*Elec Rev*-May 10.) 1400 w.

*31913. Defective Chimney Flues. John Millar (Dom Eng-May.) 1500 w.

31925. Heating and Ventilation of the Pennsylvania Railroad Station at Philadelphia. Ill. (Heat & Ven-May.) 1200 w.

31926. Ventilation in New York City. Fred P. Smith (Heat & Ven-May.) 2500 w.

31927. Loss of Efficiency in Direct Radiators Due to Massing of Surface. Ill. R. C. Carpenter (Heat & Ven-May.) 1000 w.

31993. Furnace Heating With a Fan. Ill. (Met Worker-May 25.) 1600 w.

*32055. The Ventilation of Hospitals and the Treatment of Infected Air. Abstract from the Lancet (*San Rec*-May 17.) 1800 w.

32080. A Church Hot Water Heating and Ventilating System.—St. George's Episcopal Church, Flushing, N. Y. Ill. (Mas St Fit-May.) 700 w.

32166. Heating a Conservatory at Northampton, Mass. Ill. (Eng Rec-June 1.) 900 w.

32167. School Ventilation. Samuel A. Heins (Met Work-June 1.) 1000 w.

32170. Heating and Lighting of a Model School Building. Ill. C. B. J. Snyder (Arch & Build-June 1.) 1300 w.

32245. A Dwelling-House from a Sanitary Point of View. Isaac Young (*San Rec*-Began May 24—2 parts to date—30 cts. each).

32171. Heating and Ventilation of Churches. F. E. Kidder (Arch & Build-June 1.) 3800 w.

32330. Single-Pipe Hot Water Heating. Ill. William Beall (San Plumb-June 1.) 2500 w.

Landscape Gardening.

*32034. "Treillage." Ill. John Belcher, with Discussion (*Builder*-May 18.) 5000 w.

32104. The Debt of America to A. J. Downing. Editorial (Gar & For-May 29.) 1600 w.

32116. The Standard of Taste for Parks (Soc Ec-June.) 2500 w.

Plumbing and Gas Fitting.

31924. Bending Wrought Iron Pipe. Ill. William Beall (San Plumb-May 15.) 2000 w.

*32054. Qualifications Required by Plumbers to Fit Them as Sanitary Inspectors. J. Radcliffe (*San Rec*-May 17.) 3300 w.

Miscellany.

*31626. Pre-Historic Sanitation (Abstract.) Boyd Dawkins (*Brit Arch*-April 26.) 800 w.

*31665. The Modern Kitchen (*Plumb & Dec*-May 1.) 600 w.

*32039. A Healthy Home. Anon. (*Ill Car & Build*-May 17.) 1500 w.

Serials.

26907. Hot Water Heating and Fitting. Ill. J. L. Saunders (Heat & Ven-Began Nov., 1894—6 parts to date—15 cts. each).

29334. Technical Subjects That Plumbers Should Know. Ill. F. Dye (*Plumb & Dec*-Began Feb.—4 parts to date—30 cts. each).

30985. The Heating of Dwelling Rooms. Walther Hempel (Am Man & Ir Wld-Began April 12—2 parts to date—15 cts. each).

31223. On Bathing and Different Forms of Baths. William Paul Gerhard (Arch & Build-Began April 27—Ended May 11—3 parts—15 cts. each).

31229. Plumbing in the Constable Building. Ill. (Eng Rec-Began April 27—3 parts to date 15 cts. each).

We supply copies of these articles. See introductory.

ELECTRICITY

Modern Central-Station Practice.

IN the May number of the *Sibley Journal of Engineering* is given in full a lecture delivered by S. Dana Greene before the students of Sibley College, containing an up-to-date *résumé* of the state of the art of central-station engineering. The author states that there are now 2500 central stations in the United States, representing aggregate assets of over $300,000,000. The design of the original installation, upon which the fixed charges depend, has also a direct and permanent influence upon operating expenses, but, the money having been spent, existing appliances must be utilized as best they may be under the circumstances. On the other hand, both the gross earnings and operating expenses are largely dependent upon management, and it is here that the well-instructed mind finds a field of unlimited extent and of attractive possibilities. The country is filled with horrible examples of how central stations should not be erected. The building should be of brick and steel, one story in height, the boilers separated from the dynamo room by a heavy fire-wall. The tendency of all new plants is towards high steam-pressure, and the type of work approaches that of standard marine engineering. A complete system of automatic distribution of oil is recommended. Compressed air is a convenient means of cleaning dynamos. The best practice locates the switchboard and regulating apparatus in a gallery at one end of the dynamo room, commanding a clear view of the whole place. Belting and countershafting are extravagant in space and inefficient in operation; hence the modern tendency is towards vertical compound engines of the marine type, with a generator armature directly coupled to each end of the shaft. This plan was conceived and carried out 15 years ago by Edison in his first central station in New York city, but his ideas were ahead of his time, simply because manufacturers had not then the experience and skill to carry them to their logical conclusion. In determining the dimensions of the generating units, great caution should be exercised; due regard must be given to maximum load, average load, and change of load during 24 hours. For economical reasons direct-connected units should not be operated at less than 60 to 70 per cent. load; yet they should be of equal size, so far as the above conditions admit, in order to secure interchangeability of parts and economy in attendance. The practice of using different classes of generators for incandescent-lighting, arc-lighting, and power-service is disappearing. All these services are now supplied from common mains by direct-current low-tension generators, and recent improvements in multiphase, low-frequency alternating generators, arc-lamps, and induction motors make it possible to effect the same results with alternating currents. The largest alternating station in the country (St. Louis, 150,000 16-c. p. lamps equivalent connected load) is now being remodeled to this end. All generators of like type, whether direct or alternating, are now operated in multiple, feeding into common bus bars, from which service feeders are taken off as required.

Devices are in use for raising or lowering pressure upon individual sets of feeders, as variations in length or load may require, the bus-bars being maintained at a constant pressure midway between the extremes required by the several feeders. In some cases a combined direct and alternating plant has been found economical (*vide* account of Brighton plant, in another note). Storage-battery plants are successfully used abroad, but in this country, owing to the greater proportion of day-load from motor-service, etc., the cases where they can be economically used have thus far been few. Conductors within the stations are mounted wholly on porcelain supports. Many of the larger stations in this country do not contain a

pound of combustible material of any kind [except coal]. In laying out a system of distribution, the loss of voltage should be confined practically to the feeders, which can be done by careful computation; the three-wire system of mains effects a large saving of copper, and is always to be preferred. In some of the direct-current low-tension plants in our large cities, the loss in the entire distribution system is less than 20 per cent., and the depreciation less than 2 per cent. per annum. For economical reasons the area of low-tension service must be confined to an area within about 1 mile of the station. Hence the expense of erecting so many stations is enormous (there are five in New York city), and may become prohibitive. The single-phase alternating system with two-wire 50-volt secondaries, though in extensive use in this country, is limited in the character of its service, and uneconomical in its results. The recent development of the phasal modifications of this system have, however, enormously increased its possibilities of usefulness, so that now it not only presents most of the advantages of the direct current systems, but is capable of economically covering a far greater area from a given station. The characteristic features of such a system are: (1) large transformers, banked at sub stations; feeders at 2000 volts or more carried to these sub-stations, and the consumers served thence by three-wire secondary mains of 220 volts, the mains from different sub-stations being inter-connected; (2) generators coupled in multiple arc; (3) frequency reduced to about 60 cycles per second, reducing loss from impedance in conductors and giving better motor service; (4) high-efficiency incandescent lamps, arcs, and induction motors supplied from secondary mains; (5) pressure on secondary mains constant within 2 per cent., and entire loss on distributing system not exceeding 10 per cent. Many stations might remodel their existing plants in accordance with this practice with the utmost advantage. The public is becoming more exacting as to the character of its electric service, and meanwhile the competition of gas and other illuminants is steadily forcing down the price of current. These conditions must be met; hence it is poor economy to patch up an old plant with its inherently high operating-expenses and defective service. Remodel, but do not patch. In recent practice fuses are omitted in the distributing mains and at junction-points between feeders and mains.

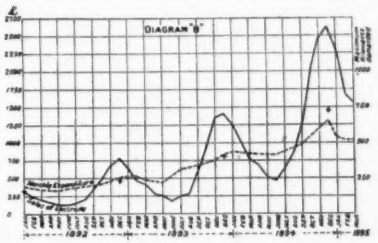
The kilowatt is becoming the universal unit of electric energy, both for charging customers and computing the cost of production. Every consumer should have a watt-meter to be read once a month, and the central-station a recording watt-meter to measure the total output; the loss on the lines can thus be checked by the difference in readings. The most profitable customers are those who use the current for the greatest number of hours; unfortunately the great majority consume current for a few hours only, and then all use it at the same time; consequently the output varies widely during the 24 hours. The "load-factor" is the ratio between average and maximum load, and the central-station manager seeks to make this as high as possible by finding uses for current outside of lighting hours. The usual method of charging 12 to 20 cts. per kilowatt-hour takes no account of the customer's load-factor; for example, one may use 2 k. w. 24 hours per day for 30 days, and another 24 k. w. 2 hours per day for 30 days; each would be charged for 144 k. w. hours; the first customer provides a steady and profitable load for the station; the second an unsteady and undesirable load; in equity the first consumer ought to have his current at a lower price. In many stations abroad the discount on the customer's bills is based largely on his load-factor. The load-factor of many European stations is only 15 per cent.; it is 33 per cent. in London, while in this country it runs as high as 40 and even 50 per cent. in the better class of stations. This great difference is principally due to the more extended use of motors in this country. During two years past 30,000 arc-lamps have been installed on incandescent circuits in this country. There is a growing demand for current for electro-metallurgy and med-

ical and dental work, as well as for heating and cooking. All such demands tend to diversify the load and increase the load-factor, and should be encouraged in every way. If the first duty of a manager is to increase his gross revenue and his load-factor, his second duty is to reduce his operating expenses. A record of the station load should be made at least hourly; every pound of coal, oil, or waste, should be accounted for. Operating expenses should be carefully analyzed and tabulated. The principal items are: fuel, oil, and waste; water; labor; renewal supplies; repairs to plant; repairs to lines; insurance; salaries and office-expenses. At the end of the month each separate item should be footed up and averaged for each kilowatt-hour output. The operating expenses of a well-managed plant (except in small towns) should not exceed 50 per cent. of gross receipts; in some large stations it runs as low as 33 per cent. Apparatus and station should be kept scrupulously clean; nothing decreases efficiency and increases repairs more effectually than dirt. A regular system of inspection and reports is necessary, and, when anything is out of order, it should be attended to at once. If a local company is to be successful and keep pace with the growth of business, the following rules must be kept in mind: Let local conditions be thoroughly studied and digested; then select the apparatus and methods of distribution best suited for these conditions, and make the plant as complete and economical as the state of the art admits; make wise provision for future increase; create the greatest possible demand for electric power; make the charges reasonable, and with due reference to the load-factor of the customer; analyze the monthly operating expenses, and effect a saving wherever possible; keep everything clean and in thorough repair; and, finally, do not pay dividends unless they have been earned, after paying all charges and allowing for depreciation and reserve fund. This is one of the most suggestive and valuable essays upon the subject of which it treats that in extensive reading has ever come under our notice.

Central-Station Experiences.

ONE of the most profitable papers which has found its way into print for some time is, in our opinion, that read by Arthur Wright before the Municipal and County Engineers and published in the *Electrical Engineer* (London) of May 10. Mr. Wright states that Brighton was the first town in England in which a central station was established; the first in which current was sold by meter; the first to adopt a differential rate of charge based on actual cost of supplying each consumer; and the first to make simultaneous and conjoint use of the direct and alternating systems of distribution. It also enjoys the perhaps unique distinction of having suffered from four different systems of distribution within 10 years. Mr. Wright showed from the board of trade returns of 1894 that the actual cost of supplying electricity from the works of the Brighton corporation was less than from any other central station in Great Britain, and that, taking all the towns of over 50,000 inhabitants, the sale of electricity per capita was greater in Brighton than in any other place. The figures of cost given range from 2.3 pence in Brighton to 3.72 pence in London. It was pointed out that the cost of continuing to produce electricity, after everything has been put in readiness, constitutes an extremely small portion of the total expenditure. Diagram B shows how very slightly the total monthly cost of running the station is affected by the actual quantity of current sent out. The crosses indicate the time of maximum demand each year. It is apparent that the total monthly expenditure depends much more largely on the maximum rate at which current has to be supplied in any one year than on the actual quantity that has been supplied. The scale of charges has been devised in accordance with these facts. The ordinary rate of 7d. (14 cents per k. w. h.) is reduced to 3d. (6 cents) whenever the due proportion of cost of having to be ready to supply any particular individual has been met by revenue derived from his previous consumption in the same half-year, at the first-named rate. Thus those who use current regularly 4 hours per day

are supplied at 4d. per unit. Diagram C shows how rapidly the cost of supplying electricity diminishes as the length of time the demand is in force increases each day. Although at Brighton station coal costs over 20s. ($5) per ton, yet the author says that, owing to the long hours of consumption,— nearly 11 hours per day,—current can be supplied for street-lighting at a profit at 2d. per unit (4 cents



per k. w. h.). No other kind of artificial illumination can successfully compete with electricity at this figure. In view of the above considerations, Mr. Wright thinks that too much attention has been devoted by central-station engineers to the matter of the reduction of running cost, to the neglect of the more important question of the reduction of the much greater standing costs involved in supplying electricity. He gives great credit to Mr. Ward Leonard, the American engineer, who pointed out as long ago as 1892 that the obvious corollary from the well-recognized fact of the low-tension system being the

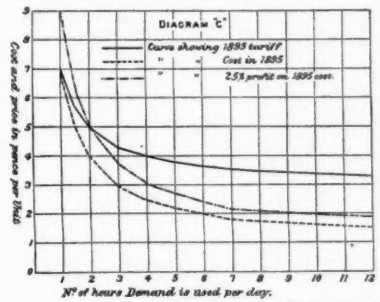


DIAGRAM "C"
Curve showing 1895 tariff
Cost in 1895
2.5% profit on 1895 cost.
Cost of unit supplied per hour.
Nº of hours Demand is used per day.

most efficient at light loads and the high-tension at heavy loads must be that some combination of the two ought to give the maximum efficiency; and it was clear that, providing the details could be satisfactorily worked out, as they now have been, it must necessarily be more economical to run only the high-tension alternating system when the demand is heavy, and at all other times to supply the residential districts from the low-tension continuous-current system, and not continue the use of the alternating supply when the only reason for its use has ceased to exist,—*viz.*, big loads at long distances. In Brighton, transformer chambers are placed at convenient points, from which extend low-tension distributing mains for supplying residences at times of heavy load, and these mains are switched on to the low-tension mains at certain convenient points during times of light load. Meters are employed which register equally well either direct or alternating currents. As the period of light load lasts on the average ten times as long as the period of heavy load, it is clearly not advisable to supply through transformers districts which can be supplied with much less loss through the ordinary low-tension distributing mains. If the proof of the pudding is in the eating, we think that Mr. Wright has made out his case. The lowest cost of production coupled with the largest consumption per capita of any town in the kingdom indicate pretty certainly that his 10 years of experience in central-station lighting have taught him some valuable lessons, by which many others might well profit.

Electricity of Elevated Railways.

THE first elevated railway in the United States, of permanent construction, operated entirely by electricity is that of the Metropolitan Company of Chicago, a somewhat full description of which appears in the *Electrical Engineer* (May 15). This line is unique, not only in that it is operated by electricity, but in that it is built upon its own purchased right-of-way, no other franchise having been sought and obtained from the municipal authorities than that of crossing the public streets at an elevation. Title to the necessary land has been obtained at a cost of some $6,000,000, and most of the purchases are now held by the company in fee-simple. All buildings on the location worth preserving

were carefully removed to other locations, the rest being demolished. One of the buildings successfully removed was the Normandie flats,—an immense stone structure. Generally the line passes through the centre of the blocks. For a distance of two miles westward from its principal terminus in the heart of the business district of the city, four tracks have been provided, beyond which four two-track lines spread out fan-like in different directions, all of the latter, with the exception of the southwestern line, being now completed. Two of the four trunk-line tracks will be used for express service. The power-station is 300 ft. by 90, and has a present capacity of 6000 h. p. There are four engines of the inverted compound direct-acting Corliss type,—two of 2000 h. p. and two of 1000 h. p.,—and 12 boilers of 300 h. p. each, fitted with mechanical stokers and smoke-consuming devices. A safety-valve in the main steam-pipe is arranged to automatically close the instant the speed exceeds a determined rate, as a safeguard against fly-wheel accidents. The entire electrical equipment—generators, motors, and accessories—was furnished by the General Electric Company. The present outfit comprises two 1,500-k. w. generators and two 800-k. w. generators, which are designed to withstand a temporary overload of 60 per cent. The generators are placed between the high and low-pressure sides of the engines, and are thus enclosed by the engine frames. The current is conducted from the station by heavy feeder-cables to a lateral third rail, which serves as a working conductor. This is outside of and above the service rails, and is bonded with copper strips. Each motor truck is equipped with a sliding contact-shoe which runs on the third rail, being flexibly suspended from an oaken beam projecting laterally from the truck-frame. The motors are of the single-reduction type, and are rated at 100 h. p. each, under normal conditions. The maximum speed capacity is between 30 and 40 miles per hour. The average speed on the suburban portion of the line, including stops, is about 13 miles per hour. The road commences operations with an equipment of fifty five motor cars and one hundred trail-cars.

Electrolytic Reduction of Aluminum.

THE *Western Electrician* (April 20) contains an interesting illustrated paper describing the electric plant of the Pittsburg Reduction Company, at Niagara Falls. The transformers are nearly in readiness to receive current from the power-house. The outfit comprises four rotary transformers of 500 h. p. each and eight stationary transformers of equivalent aggregate capacity. The cables from the power-house are four in number, and laid directly on the floor of the subway. The conductors in these cables are each 950,000 circular mils area of cross-section. The two-phase alternating current from the power-house is delivered at a pressure of 2000 volts, which is reduced to 115 volts by the stationary transformers, and then by means of the rotary transformers re-converted into a direct current of 160 volts, after which it is ready to be conducted to the electric furnaces in which the aluminum is smelted. The capacity of the apparatus is 10,000 amperes at 160 volts. The stationary transformers are cooled by means of an air-blast.

The Danger-Line in Electric Pressure.

IN reference to a case reported not long since, in which the operator of an electric mining machine was killed, as circumstances appeared to indicate, by an electric current of a potential of 280 volts,—but little more than half that which has usually been regarded as the outside danger-limit,—Mr. Richard Lamb, in a communication to the *Electrical Engineer* (May 8), says that too much publicity cannot be given to the fact that even so low a pressure as 110 volts may prove fatal, if applied to a bleeding sore and allowed to remain for a few minutes. With 280 volts applied under similar conditions the person would be killed almost instantly. The explanation which the writer offers is that the blood is so good a conductor that the current is transmitted through the arteries and veins directly to the heart. It is not improbable that some of the mysterious deaths which

have been reported from what are ordinarily regarded as perfectly safe currents may be explainable in this way.

Interior Electric Wiring.

IN the *Architect and Builder* (December–January) is an excellent paper on the above subject, read by Charles E. Burton before the Northwestern Electrical Association. Mr. Burton thinks it is very little to the credit of the electric-light companies, or the business of electric lighting, that the underwriters have been compelled to take the initiative steps towards the improvement of the electric business. If the standard of electric wiring has fallen so low as to require the rigid supervision and inspection now exercised by the underwriters, it is quite time that the electric companies sought to protect their own interests by guarding against the introduction of poor labor and poor material. Now that electrical engineering has assumed the dignity of a permanent profession, it should no longer require such surveillance by those who claim to have received injury from the failure of the electrical companies to conduct their business on a safe basis. We would think very poorly of a physician whose prescriptions required inspection before they could safely be used. The underwriters have learned by costly experience that electric-light companies as a rule are exceedingly negligent in the inspection of the interior wiring to which they attach their supplying conductors, and hence they insist that they themselves shall, by rigid inspection, discover and point out the hazards, and compel their correction. Mr. Burton thinks that the ideal system of wiring, from the point of view of greatest security and insulation, is exposed, heavily-insulated wire, supported upon non-combustible insulators. For concealed work he predicts the universal adoption of the iron-armored conduit, which, he thinks, meets every requirement of engineers as a permanent mechanical protection for interior wiring.

An Extensive Water-Power Project.

THE Minnesota Canal Company, an organization of Chicago capitalists, is reported by the *Railroad Gazette* as having made surveys along the north shore of Lake Superior for a distance of 100 miles northeast of Duluth, Minn., with a view of utilizing the waters of the numerous small streams flowing from the high ground north of the lake, and conducting them through a canal 80 miles in length to a reservoir some 600 ft. above the water-front of that city. The plan is to distribute the water from this reservoir in pipes to furnish power for manufactories along the water-front, as well as to convert a considerable portion into electric power to be used for general purposes. It is computed that power can be furnished for not more than $10 per h. p. per year. The original plan was to utilize the water of the St. Louis river, which flows into the lake from the southwest, and has a rapid fall. The volume of water in this river was found upon investigation to be extremely variable, ranging between such wide extremes as 250 cu. ft. and 17,000 cu. ft. per second, rendering extensive provision for summer storage necessary. The north shore streams have been found to be much more constant in their flow. The company has secured the necessary legislation, and has instituted condemnation proceedings for acquiring the necessary rights of way for the whole length of the canal. It is estimated that the cost of the entire project will not exceed $4,000,000. It does not appear that any actual construction work has yet been done.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Electricity in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

Lighting.

*31633. Interior Conduit and Interior Wiring. Charles E. Burton (Arch Build & Dec–Jan.) 2300 w.

*31662. Decorative Electric Lighting. Ill. (*Elec Rev*–May 3.) 4500 w.

†31670. Lighting Installations. H. A. Henderson (*Ind & East Eng*–April 6.) 2000 w.

We supply copies of these articles. See introductory.

*31693. Leicester Electric Light and Power Station. Ill. (*Elect'n*-May 3.) 2000 w.

31765. Scientific Fishing—Use of the Electric Light. From Chicago Tribune (Sta Eng-May.) 1500 w.

*31866. Points of Interest in the Development of Electricity Supply at Brighton. Arthur Wright (*Elec Eng*-May 10.) 2200 w.

*31955. Some Suggestions on Central Station Practices, with Special Reference to Developments during the past year. S. Dana Greene (Sib Jour Eng-May.) 6000 w.

*32040. The Recent Development of the Single Acting, High-Speed Engine. Editorial in paper by Mark Robinson (*Elec Rev*-May 17.) 2800 w.

*32047. Cheltenham Electricity Works. Ill. (*Elec Eng*-May 17.) 6000 w.

32145. Non-Magnetic Arc Lamp. Ill. W. E. Irish (W Elec-June 1.) 700 w.

32292. A Combination Alternating and Direct Current Plant—Budapest, Hungary. Ill. (Elec Wld-June 8.) 3000 w.

30806. Alternate Current Motors. W. G. Rhodes (*Elec Rev*-Began March 29—2 parts to date—30 cts. each).

30872. Telephony. Ill. V. Wietlisbach (Elec Engng-Began April—2 parts to date—15 cts. each).

30938. Lighting and Electric Lighting as a Business. George White Fraser (Can Elec News-Began April—Ended May—2 parts—15 cts. each).

30939. Dynamo Design. E. B. Merrill (Can Elec News-Began April—2 parts to date—15 cts. each).

30973. Electric Mains in Paris. A. Monmerque (*Elec Eng*-Began April 25—3 parts to date—30 cts. each).

31284. Electric Lighting on Trains. Ill. R. W. Weekes (*Elec Eng*-Began April 19—2 parts to date—30 cts. each).

31344. Practical Telephony. Ill. James Bell (*Elec*-Began April 19—7 parts to date—30 cts. each).

31530. Alternating and Interrupted Electric Currents. Report of Lectures by George Forbes (*Elec Rev*-Began April 26—3 parts to date—30 cts. each).

31859. The Chemnitz Central Station. Ill. (*Elec Rev*-Began May 10—Ended May 17—2 parts—30 cts. each).

31865. On the Recent Development of the Single-Acting, High Speed Engine for Central Station Work. Mark Robinson (*Elec Eng*-Began May 10—Ended May 24—3 parts—30 cts. each).

31934. Accumulator Battery for Telegraphic Purposes. Directions for Installation and Maintenance. Ill. Harry Hofmeister (Elec Rev-Began May 22—Ended June 5—3 parts—15 cts. each).

32038. Nikola Tesla and His Work. Anon. (*Ill Car & Build*-Began May 17—2 parts to date—30 cts. each).

32164. The Shops of the Westinghouse Electric and Manufacturing Company. Ill. (Eng Rec-Began June 1—1 part to date—15 cts).

32246. Atmospheric Electricity. A. Schuster (*Elect'n*-Began May 24—Ended May 31—2 parts—30 cts. each).

32254. Recent Experiments on the Electric Discharge, by Lord Armstrong. Ill. (*Elec Rev*-Began May 24—Ended May 31—2 parts—30 cts. each).

*32360. Electric Lighting at Hong Kong. Ill. (*Elec Rev*-May 31.) 1600 w.

*32363. Cheltenham Electric Lighting. Ill. (*Elec Rev*-May 31.) 3000 w.

Power.

†31674. The Electrical Transmission of Power. William M'Whirter (*Ind & East Eng*-April 13.) 3500 w.

*31691. Electrical Plant at the Crewe Works. Ill. (*Elect'n*-May 3.) 1900 w.

*31858. An Interesting French Electric Lighting and Power Transmission Plant. Ill. (*Ind & Ir*-May 10.) 2400 w.

*31874. Electric Welding for Repairs. Editorial (*Engng*-May 10.) 1700 w.

31882. An Electric Mining Plant. J. J. Ormsbee (Tradesman-May 15.) 900 w.

31953. Coal Handling by Electricity. Ill. (Ir Age-May 23.) 800 w.

*32032. Rotary-Current and Alternating-Current Dynamos of the Allgemeine Elektricitats Gesellschaft. Ill. M. von Dolivo Dobrowolsky (*Elect'n*-May 17.) 1000 w.

32070. Hints upon Daily Work about a Dynamo Plant. Pliny Norcross (St R'y Elec News-May.) 3000 w.

32134. The Possibilities of Electrical Pumping Machinery. Charles A. Hague (Eng News-May 30.) 1000 w.

32146. Some Practical Hints in Dynamo Design. Ill. Gilbert Wilkes (W Elec-June 1.) 3800 w.

32326. Electric Driving of Tools in the Baldwin Locomotive Works, Philadelphia. Ill. Patrick Drolan (Am Mach-June 6.) 2000 w.

Telephony and Telegraphy.

31715. Electrolysis of Underground Cables of the Wisconsin Telephone Company in the City of Milwaukee. E. M. Dexter (Elec Engng-May.) 2200 w.

31720. Telephonic Communication between Light-Ships and Shore (Elec Age-May 11.) 1200 w.

31823. Plans of the Wisconsin Telephone Company (West Elec-May 18.) 1000 w.

31824. Annual Meeting of New England Telephone and Telegraph Company (West Elec-May 18.) 2200 w.

*31855. The Madagascar Cable (*Elect'n*-May 10.) 800 w.

31935. Berliner Patent Upheld (Elec Rev-May 22.) 2800 w.

32085. The Telegraph Service of Great Britain (R'y Rev-May 25.) 1000 w.

†32095. A Cable Post.—The Possibilities of Atlantic Submarine Communication. J. Henniker Heaton (N Amer Rev–June.) 4000 w.

32127. The Mexican Government Telegraph Service—The Zone System of Rates. Ill. George Heli Guy (Elec Eng–May 29.) 2800 w.

32159. Berliner Telephone Patents. Ill. (Elec Wld–June 1.) 2500 w.

32168. Visual Sound-Writing by Word of Mouth. W. E. Irish (Elec Age–June 1.) 1100 w.

32278. The Telephone Situation—Wondrous Growth of the Independent Companies (Elec–June 5.) 4500 w.

Miscellany.

31583. Non-Magnetic Electric Devices. Ill. W. E. Irish (Elec Eng–May 8.) 2500 w.

*31684. The Effects of Electric Currents in Iron on Its Magnetism. J. Hopkinson (*Elec Eng*–May 3.) 3200 w.

*31695. Variation of Internal Resistance of a Voltaic Cell with Currents. Henry S. Carhart (*Elect'n*–May 3.) 800 w.

31716. Conductor Materials. Frederic A. C. Perrine (Elec Engng–May.) 2500 w.

31717. Elements of Complex Quantities and Vectors with Reference to Their Use in Alternating Current Work. F. J. Dommerque (Elec Engng–May.) 2000 w.

31801. The Quantity Upon Which a Knowledge of the Nature of Electricity and Magnetism Depends. Reginald A. Fessenden (Elec Wrld–May 18.) 1000 w.

31802. Experiments with Electric Waves. Alfred G. Dell (Elec Wld–May 18.) 1000 w.

31803. Contribution to the Theory of Demagnetization. Edwin J. Houston and A. E. Kennelly (Elec Wrld–May 18.) 1300 w.

*31834. Is Vitality Electrical? (Self Culture–May.) 2800 w.

*31854. Representation of Periodic Currents by Polar Diagrams. J. A. Fleming (*Elec'n*–May 10.) 1200 w.

*31857. On the Electrification of Air. Ill. Lord Kelvin (*Elect'n*–May 10.) 1800 w.

31941. Microscopical Research in the Electrostatic. Ill. George T. Hanchett (Elec Wld–May 25.) 1400 w.

*32029. The Zickler Universal Electro Dynamometer. Ill. (*Elect'n*–May 17.) 1800 w.

*32041. Cyanide of Potassium and Electricity. Emile Andreoli (*Elec Rev*–May 17.) 3500 w.

32128. Electrical Thermal Devices. W. M. Stine (Elec Eng–May 29.) 1500 w.

32160. On a Possible Law of Residual Magnetism in Iron and Steel. Edwin J. Houston and A. E. Kennelly (Elec Wld–June 1.) 600 w.

*32190. Uses of Accumulators. J. C. Howell (*Elec Eng*–May 24.) 4500 w.

†32222. Lightning Arresters, and Why They Sometimes Fail. Ill. Alexander Jay Wurts (Jour Fr Inst–June.) 4200 w.

*32247. Graphical Methods of Finding Mean Square Values. Alexander Russell (*Elect'n*–May 24.) 500 w.

*32249. Variations of Electrical Pressure in London. A. A. C. Swinton (*Elect'n*–May 24.) 500 w.

32280. An Unpremeditated Execution. Herbert Laws Webb, in "Electric Power." (Elec Rev–June 5.) 5000 w.

32291. On the Causes Producing Phase Differences in Alternating Current Circuits. Edwin J. Houston and A. E. Kennelly (Elec Wld–June 8.) 1100 w.

32293. Self Induction and Capacity. E. B. Rosa (Elec Wld–June 8.) 3500 w.

32297. Electricity in the Bleaching of Textile Fibres. Louis J. Matos, in Textile Industries (Sci Am–June 8.) 2400 w.

32315.—75 cts. Studies on the Voltaic Cell. H. M. Goodwin (Tech Quar–Dec.) 11500 w.

*32362. Variation of Internal Resistance of a Voltaic Cell with Current. Henry S. Carhart, in the Physical Review (*Elec Rev*–May 31.) 700 w.

*32376. Resonance in Transformer Circuits. Frederick Bedell and Albert C. Crehore, in the Physical Review (*Elec Eng*–May 31.) 3000 w.

*32377. Present Range and Accuracy in the Measurement of Electrical Resistance. Herschel C. Parker, in Electric Power (*Elec Eng*–May 31.) 700 w.

*32381. A Contribution to the Theory of Demagnetization. Ill. Edwin J. Houston and A. E. Kennelly (*Elect'n*–May 31.) 1200 w.

Serials.

6515. Notes on Submarine Cable Work. Ill. H. D. Wilkinson (*Elect'n*–Began Sept. 2, 1892—15 parts to date—30 cts. each).

22059. Practical Notes on Dynamo Calculation. Alfred E. Wiener (Elec Wld–Began May 19, 1894—34 parts to date—15 cts. each).

23866. Electrodynamic Machinery. Ill. Edwin J. Houston and A. E. Kennelly (Elec Wld–Began July 21, 1894—37 parts to date—15 cts. each).

24536. Principles of Dynamo Design. Newton Harrison (Elec Age–Began Aug. 25, 1894—28 parts to date—15 cts. each).

25895. The Design and Specification of Electric Lighting Works for Architects and Civil Engineers. Howard Pentland and Alfred H. Gibbings (*Elec*–Began Oct. 5, 1894—35 parts to date—30 cts. each).

27371. The Electric Light. Henry Stooke (*Ill Car & Build*–Began Nov. 23, 1894—27 parts to date—30 cts. each).

27506. Suggestions in Preparing Specifications for the Electric Lighting of Buildings. Nelson W. Perry (Eng Rec–Began Dec. 8, 1894—4 parts to date—15 cts. each).

29158. The Construction and Use of Electrical Measuring Instruments. Charles H. Yeaman (*Elec*–Began Feb. 1—15 parts to date—30 cts. each).

INDUSTRIAL SOCIOLOGY

The Commercial Union of The States.

UNDER this title *The Railway Review* (May 11) printed a report of a witty and pithy address delivered by Mr. Chauncey M. Depew before the Detroit chamber of commerce May 2, 1895. There is in this address food for serious reflection, as well as much that is amusing. The speaker has a world-wide reputation for dressing strong intellectual meat in the most inviting form.

"Whatever political differences may divide the sections of our common country, there is an intelligent union of interest among its business men. There may be a clashing upon party lines between Michigan and Missouri, New York and Georgia, Pennsylvania and Alabama, Maine and California, but the chambers of commerce and the boards of trade of New York and San Francisco, of Portland, Me., of Philadelphia and Atlanta, of Detroit and New Orleans, of Savannah and Duluth, of Chicago and Charleston, consider the questions which affect the business and the commerce, the trade, and the agricultural and the manufacturing interests of our country upon the recognized principle of commercial prosperity and the immutable laws of trade. Thus it is that the commerce of the United States is the ever-strengthening bond of union of the commonwealths which constitute the republic. It is significant of the rapidity with which the American people escape the thraldom of prejudices, misrepresentation, and demagogues that we, who are interested in so large a part of the railway ownership and management of the United States, should be participants in this celebration with gentlemen who represent every industry of this great and thriving State. The time has come when the people of the United States, with but few exceptions, are recognizing the fact that the farm, the factory, the mine, the mill, and the railroad are inseparably and independently connected, and that the prosperity of any one of them benefits all, and an injury to any one of them is an injury to the rest."

Speaking of the change in the attitude of State legislatures toward railroads, which now for the most part is favorable, it was remarked that this assertion of "common sense over rabid sentiment" was first manifested in New England. New York, in 1888, "presented at the national Republican convention the president of its chief railway as the State's candidate for president of the United States . . . Well-meaning men used to come to my room as a matter of curiosity with an accident-ticket in one pocket and a prayer-book in the other. The one provided for their familes in case the evil one should whisk them off to the infernal regions, and the other presented the usual and time-honored method of exorcising the devil. My head was curiously examined to find the evidence of horns,—I mention horns, however, with considerable modesty, since the governor of the State of Illinois has recently declared that I do not know on which end of the animal horns grow. It is now, however, generally admitted that, whatever progressive position the railway may have once taken, it no longer asks anything except to be considered in the same light as other occupations and other properties. Its position can be accurately stated in the language of the mate of the whaling schooner when the surly captain had offered him, because of his success in capturing one of the monsters of the deep, promotion, honorable mention, and a share in the profits. Said the mate: "Capting, I don't want no promotion. I don't want no honorable mention. I don't want no share in the profits. All I want is common civility, and that of the darndest commonest kind."

Of the present age Mr. Depew said that "steam, electricity, and inventions have so accelerated the pace of progress, have so reduplicated the forces of industry and trade, that the individual has lost his place. Capital combines in corporations, not only

where it is required in vast sums for railways and telegraphs, but in lumbering, mining, manufacturing, and store-keeping. Labor combines, both in separate industries and in general federation. The educator and the scientist discover that development is so rapid that they also must form associations if they would keep step with the truth. The unit upon which liberty formerly relied must now be a drilled and disciplined soldier assigned to his company, his regiment, his brigade, and his corps." Of all the forms of commercial association, chambers of commerce are the most beneficent. When a man steps from the realm of business to enter a political career, "the effort to spread himself all over this great country seems to so thin his gray matter as to make him incapable of bringing to the business of the nation the same common sense which made him succeed at home." As proof of this, the congress that has recently adjourned is cited. Mr. Depew, however, does not indicate whence our legislative bodies are to be better recruited, since he applied the same remark to professional men who fatuously engage in politics. The address concludes with a restatement of Mr. Depew's well-known views on the currency question, and some remarks upon the close relation of our educational systems and the material development of the country.

Cure for Slums.

THIS subject is discussed in *The Forum* for June by Mr. E. R. L. Gould, special agent of the United States department of labor. Drunkenness, criminality, and moral degradation, the "never-failing products of the slums," are typified by a "cancer," for which "there is no cure except the knife." There is no other "satisfactory way of dealing with irremediable insanitary premises than to tear them down." The paper therefore directs public attention toward the policy of expropriation, which "is the best militant weapon that a board of health can possess.

"Great Britain has given the most satisfactory answer to this question. Parliament more than 40 years ago recognized that the highest of all human rights is the right to live, and that a distinction should be drawn between living and existing. Lord Shaftesbury's act of 1851 remained for the most part a dead letter, but the Torrens and Cross Acts of 1868 and 1879 and the artisans' dwelling acts of 1882 effected something, while the housing-of-the-working-classes act of 1890 stands for model legislation and is doing much good. The distinctive feature of this last measure is expropriation by public authority, upon fair terms, of hopelessly insanitary property. Previous enactments gave the right to condemn insanitary houses, and even considerable areas, but their fatal defect was that based upon rental value; the slum-landlord had the advantage. More than that, the law gave him an additional motive for packing his tenements and raising his rent-roll to the highest possible limit. He was just so much better off when a jury of condemnation came to sit upon his case. But the act of 1890 changed all this. No allowance is now permitted for compulsory purchase, the price of the land being fixed at a fair market-value. If the property, or any part of it, is so bad as to constitute a nuisance, deduction is made from the value of the house for such an amount as would secure abatement and wholesome repair. If, however, the premises are unfit for human habitation or are structurally so bad that they cannot be made sanitary, salvage from the building is all that is allowed. These are terms upon which owners of rack-rented ramshackle tenements are treated; and who will say that they are not absolutely fair?" Both American and European laws permit expropriation for works of public utility, but not for purely sanitary reasons, and Mr. Gould urges that the power of expropriation should be extended to meet this requirement. Taxpayers, landlords, and tenants are all guaranteed fair treatment under English practice. The first step is an 'official representation' made by the health officer to the municipal authorities, stating that within a certain area there are houses, courts, and alleys unfit for habitation; that in this area the general health of the community is bad; that certain prevalent diseases are probably caused by the unhealthy condi-

tions of the houses and streets, or by want of proper ventilation or conveniences; and that the evils are not susceptible of remedy without an improvement scheme. The health-officer is required to inspect and report upon the condition of any area upon the complaint of two justices of the peace, or of twelve rate-payers, or he may act upon his own volition. The local authorities examine the 'representation,' declare the area unhealthy, and proceed to formulate an improvement scheme. Members in any way pecuniarily interested are excluded from voting. The improvement scheme, accompanied by maps, particulars, estimates, and statements of arrangements made for securing accommodations for displaced working-people, is then submitted for approval to the local government board, which is in one sense a national department of health. The details of the scheme are made public by advertisement, and notice is given to owners and occupiers. The local government board, having approved the plan, submits it to parliament for confirmation."

Having thus named the remedy, the author proceeds to discuss the mode of applying it in American cities in such a way that the cost would be distributed upon not only the present, but a future, generation; and he evidently regards the English method of dealing with slums as the best study in legislation directed to their extermination.

Workmen's Funds.

MR. GEORGE LIVESEY, in *The Gas World*, May 11, ably discusses the subject of workmen's funds for sickness, accident, old age, &c. The great change in the relations of employers to employed is very forcibly set forth in this paper.

"It has been said that the way to deal with labor is to make use of it so far and so long as it answers the purpose, and then to cast it off. Employers are not so much to blame for this opinion, because it is the direct outcome of the policy of the trade unions. Humanity and the common sense of the employers prevent the general adoption of this hard and short-sighted system, of which the only possible justification would be the impossibility of something better; and, happily, better things are possible. When businesses were small, and master and men lived together, and where fair and considerate treatment prevailed, mutual goodwill was the result. Now such friendly personal relations are impracticable, partly because in large businesses employers cannot know their men individually, and partly because they and their men and the circumstances of both have changed, and separation, with prejudice and mutual want of confidence, are the rule. The old relations of master and servant are gone beyond recall; the object now must be to make the new relations of employers and employed better than the old. To say this cannot be done is to admit that the industrial world is retograding in its most important particular, for the men are more than their work. It is more important that men, in the highest and best sense, should be made than any mechanical or industrial work they can accomplish. If, therefore, employers and employed are to be, and to remain, at enmity, the new is undoubtedly worse than the old; but we need not despair; the prize is well worth winning, but, like all other good things, it can only be won by well considered, patient endeavor. The employer occupies a position in which he may exert great influence with his men, and ought to be, as he may be, their natural leader. If he does not take this position, so-called 'labor leaders' will do so, who would speedily lead the men, themselves, and the nation to ruin; they have gone some distance on that road already, and to show that they would do it is only necessary to quote the Collectivist resolution carried by 219 votes to 61 at the Trade Union Congress held at Norwich last year: 'That in the opinion of this congress it is essential to the maintenance of British industries to nationalize the land and the whole of the means of production, distribution, and exchange, and that the parliamentary committee be instructed to promote and support legislation with the above object.' To do them justice, one of the oldest and strongest trade unions in the country,—the boiler-makers,—led by

their secretary, Mr. Knight, have, in consequence of this resolution, formally withdrawn from the congress."

To many all this may, at first, seem foreign to the question under consideration, but it is not so. Not only have employers and employed got out of touch, but the tendency is to still greater separation. The necessity of reëstablishing satisfactory relations is pressing. "How can mutual confidence and goodwill be created? The men are suspicious and the employers doubtful as to the course to take, which necessarily tends to inaction. There is no one panacea; but this is certain,—that justice. liberality, sympathy on the part of the employer, will tell. It is he who must make the first move, and, as a step in the right direction, workmen's funds for sickness, accident, old age, &c., are recommended. There is an impression that such funds are common, but there are many prosperous . . . . accounts in which there is no item giving evidence that any such fund is in existence. If not, why not? Is it due to want of thought or want of will, or to difficulties, real or imaginary, that stand, or appear to stand, in the way?"

The trade unions appear to have arrayed themselves against all funds involving the association of employers and employed. They do not want either the ties between these two classes to be strengthened, or their hold upon the workmen to be weakened. In spite of this obstacle, the initiative step should be taken, and the employers should take it. The proper initiative is for an employer to call a meeting of the employees, in which the project may be discussed and a plan for carrying it out agreed upon. Statistics of the results of such funds as have already been organized are given. These figures prove at what small cost of trouble and money-responsibility provision can be made for relief of those temporarily disabled by sickness or accident; but they do not touch the larger questions of permanent relief and old-age pensions, for which a separate fund is necessary. "The subject of old-age pensions is one of the burning questions of the day." Germany has recently instituted a compulsory national system, while in England a royal commission has just repeated that nothing effective can be done by the State. In the case of the salaried classes, the government and many public bodies, joint-stock companies, and even private firms, make provision for superannuation by means of joint funds, and the system is very rapidly extending. "It is, in fact, becoming recognized as right and necessary, on the ground that the employer does not feel justified in dismissing an old servant when he becomes infirm, while he also feels that it is not fair to expect him to give a pension towards which the recipient has contributed nothing. The usual plan is for the salaried official to contribute a certain percentage—usually 2½ per cent.—of his stipend, to which the employer adds a like amount. Retirement takes place at 65 years of age, and the pension amounts to, but never exceeds, two-thirds of the then annual salary, if the length of service extends to 40 years or more, and one-fortieth less for each year short of that period. The fact that in the case of clerks and salaried officials the system of old-age pensions is accepted as correct, and remembering that their salaries are usually paid during temporary absence from sickness, is a good reason for making a similar provision for wage-earners."

The Doom of the Small Town.

UNDER the above title *The Forum* for April had a paper written by Mr. Henry J. Fletcher, in which the effect of changed economic conditions is considered, as manifested by the decadence of industries formerly conducted in small towns and the centralization of these industries in larger cities. Consolidation of these industries is the present tendency, and its results are far-reaching. This article attracted wide attention, and has, of course, been variously commented upon in other publications. The best review of Mr. Fletcher's paper that we have seen is one entitled "Economy of the Large" in *Social Economist*, which points out that the large is superseding the small in all commercial and social economics. "Substituting the word 'building,' or 'store,' or 'hotel,' for 'town,'

a like essay might have been written on the doom of the small building, the small store, the small hotel or boarding-house, and even the small park, the small church, and the small newspaper. Within 20 years past the small woolen factory disappeared rapidly before the large woolen factory; and during the 50 years preceding the small cotton factory had yielded to the large, as during the 50 years before that the domestic or home system of spinning, weaving, and shoe-making had gone down before the factory itself. The consolidation of many small railroads into a few large ones, and of many small oil and sugar refineries into the Standard, Havemeyer, and Spreckels trusts, is part of the same process. The substitution of large for small farms in England and Ireland, and the higher profits of ranch stock-raising, of Australia and Montana great flocks, of bonanza wheat-growing in California and Argentine, and even the gathering of upwards of sixty petty German principalities into one modern German empire, and the determination manifested in the United States in 1860 to 1865 to have one grand republic rather than a heterogeneous litter of small State-lings, are illustrations of the same idea in so many fields that Mr. Fletcher, to make his title comprehensive, should have omitted the word 'town' and written of the 'Doom of the Small,' absolutely."

Among the statistics given by Mr. Fletcher, it is shown that in Illinois out of 1424 townships 800 have lost population in the decade between 1880 and 1890, 45 have remained stationary, and only 579 have gained. In Ohio 755 townships have lost population, 32 have remained stationary, while only 529 have gained. "In Indiana, Iowa, and Michigan, the number of townships which have lost population is barely in excess, but not greatly so, and all seem to be evidently approaching the period of greater loss than gain."

At the same time the population of these States as a whole is increasing. Only one inference can be drawn from these figures; the loss of the smaller towns is the gain of the larger. But this kind of change, look where we will, has its analogue in all sorts of business. "Years ago, St. John's Park, in New York city, was taken for a freight depot because it was too small to be valuable as a park after the people had got Central and Prospect, Van Courtland, and the other Annex parks. Now Bryant Park is about to be taken for a library, because, while it is too small for a park, it will be large for a library. Seventh and Eighth avenues are filled with small stores which, when certain articles in their line are called for, reply: 'We haven't call enough for that to pay us for keeping it. You can get that at Macy's.' Thus they constantly advertise the competitor that is crushing them. Canal street has sunk in value to half or a third of its value 30 years ago, and its buildings have been for years nearly unrentable, and will continue so until the high buildings break in upon its lethargy and it becomes a vast wholesale street with buildings averaging twenty stories in height. Washington square was going to ruin for its old uses, but the first twelve-story building has invaded it, and the rest will follow."

Without further quoting the examples of the change noted in New York, the cause assigned for it is worth considering. "There has never been any difficulty in perceiving that the migration from the small factory to the large, or from the petty charcoal furnace sending up the smoke of its pig-iron smelting from a single lone chimney-stack in the mountains to the vast concern employing twelve thousand to twenty thousand men and turning out everything from a locomotive to a needle, was a necessary part in the normal evolution of industry. Is the flight from the small town to the great of the same nature and induced by the same causes as the movement of trade in cities from the small stores to the large ones,—*viz.*, to effect an increased economy of time, capital, and nerve-force, or, in short, to net a larger return to both merchant and customer at the same cost. If so, it is a ground of rejoicing only."

The Inter-State Commerce Law is held by Mr. Fletcher to be largely responsible for this decadence of the small towns. Commenting upon this opinion, *The Rail-*

way Review (May 11), which, under the title "The Re-location of Industries," also editorially reviews the *Forum* article, maintains that the cause of these changes, or at least one potent cause, is "that in most cases they [the industries] were unnaturally located, and, in order to maintain a profitable existence, were obliged to be subsidized, either by the town in which they were situated or by the railroad on which they depended for transportation." Doubtless both the causes have had their influence; but in our opinion the most potent cause, which is, indeed, included, though not specifically named, in that assigned by *Social Economist*, is that the vast increase of machine-production has crowded out the manual processes which a few years ago constituted the trades and industries of small towns. As the use of machinery has lessened cost of production, and has compelled concentration in large establishments of industries that once prospered in a smaller way, the natural tendency of population is toward the great industrial centers, and the tendency of industrial location is toward centers of population.

Why Municipal Reform is a Failure.

IN *The American Magazine of Civics* for June, Mr. Charles E. Burton writes that the failure of municipal reform cannot be questioned. "There was a time when any abuses or corruption that might happen to come to light in some particular city seemed to be a shock to the community; seemed to bring to bear in some degree a force of public opinion that carried with it at least a hope of victory over those who were, in effect, engaged in piracy upon the community's treasure. That conditions have changed in this respect, more especially during the last decade, cannot be denied. Nor is there any ignorance abroad upon the subject of corruption in city government. . . . .Any well-informed New Yorker has known for years practically all that has been proved by the Lexow investigations. These investigations . . . only brought out special instances of corruption, and succeeded in adducing legal proof of them."

The author then sets out on a search for reasons and causes, and says that, having inquired of "various persons of intelligence," he has found (as he ought to have expected) "a curious diversity of views, both as to causes and remedies," which he epitomizes as follows:

"(1) 'The foreign voter.' Remedy: anti-immigration laws. (2) 'Ignorant voters.' Remedy: compulsory education. (3) 'Decline in public morality.' Deplorable, but no definite remedy proposed. (4) 'Drink evil,' with its concomitant corruption. Remedy: prohibition. (5) 'Socialistic teachings.' Remedy: individualism. (6) 'Individualism.' Remedy: socialism." Mr. Burton then asserts that not any or all of these reasons "account for the widespread and seemingly mysterious indifference of a majority of the voters in large cities in regard to waste or robbery of the public funds."

As to the first reason it is asked: "Was not our nation with all its cities created by immigrants and their descendants? Why, then, is it so suddenly alarming that our kith and kin are still coming to join us?" Of the second it is alleged that "the proportion of ignorant voters is annually decreasing under the influence of our common-school system and widespread current literature." As to the third reason, "there are abundant reasons for thinking that the public conscience was never more sensitive and awake than at present." As to the evil of drink, "the very fact that it has become a more potent factor in politics is only concomitant to the very condition we are discussing." Socialism "is not yet sufficiently prevalent to produce an appreciable effect upon the body politic in municipal government."

"Standing on the ocean beach, one sees the perpetual roll of waves toward the shore, and wonders how there can be danger for the bathers; but the student of science knows that underneath the surface there is a silent current, known as the 'undertow,' which sometimes overcomes and drags under the strong-limbed bathers. The student of sociology knows that underneath all the talk about the rule of the majority there is a dangerous undercur-

rent of indifference in regard to what shall become of the public funds,—a feeling among the majority of the voters that the public funds are not their funds. In brief, this may be expressed as an alienation from the commonwealth, a feeling among the employed, non-property-owning classes that they have no part in the common wealth of the community. It is this alienation from the commonwealth that constitutes the dangerous political undertow; for, preach in politics as we may, so long as a majority of the voters believe that a robbery of the public funds is in no sense a robbery of their funds, just so long will they remain indifferent to it.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Industrial Sociology in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

31639. Claims of Bimetallists (Soc Ec-May.) 3000 w.

31640. The Economy of the Large (Soc Ec-May.) 2000 w.

31641. Public Effects of Great Fortunes (Soc Ec-May.) 1900 w.

31642. Prices and Volume of Money (Soc Ec-May.) 1800 w.

31643. A Colonial Experiment in Communism (Soc Ec-May.) 2400 w.

31644. The Secrecy of the Legislation Against Silver (Soc Ec-May.) 2100 w.

31676. The Commercial Union of the States. Chauncey M. Depew (Ry Rev-May 11.) 2200 w.

*31681. The Silver Question. Prize Essay by George Jamieson. 6000 w.

*31682. The Rise in the Value of Gold. Thomas Holyoake Box 4000 w.

*31683. The Fall in Silver and Its Effect on British Trade. David Octavius Croal 7000 w.

*31718. The Currency of the United Kingdom (*Bank Mag*-May.) 2600 w.

*31719. The Trade Revival in the United States. W. R. Lawson (*Bank Mag*-May.) 5600 w.

*31756. The Commercial Capital of Canada (*Trans*-May 3.) 3500 w.

31157. The Re-location of Industries. Editorial (R'y Rev-May 11.) 900 w.

*31769. Homes for the People. William E. Smythe (Milling-April.) 1400 w.

*31770. The Free Coinage of Silver on the Old Basis. Denison B. Smith (Milling-April.) 1600 w.

*31773. Clumsiness of Existing Electoral Methods. T. W. Graham (Milling-April.) 900 w.

†31776. Factory Legislation for Women. Evelyn March-Phillips (*Fort Rev*-May.) 5000 w.

31780.—$1. The Exploitation of Theories of Value in the Discussion of the Standard of Deferred Payments. Frank Fetter (An Amer Acad-May.) 5000 w.

31782.—$1. The Units of Investigation in the Social Sciences. Arthur F. Bentley (An Amer Acad-May.) 57500 w.

*31929. Workmen's Funds, for Sickness, Accident, Old Age, &c. George Livesey, with Discussion (*Gas Wld*-May 11.) 8800 w.

*31952. How Many Woman are Going into Business. Martha J. Owens (Chau-June.) 2000 w.

*31999. French Share of the Trade of Japan (*Bd of Tr Jour*-May.) 900 w.

*32001. Tariff Changes and Customs Regulations. Russia, Norway, Germany, Netherlands, France, Spain, Roumania, Greece, Persia, United States, Nicaragua, Trinidad and Tobago, British Honduras (*Bd of Tr Jour*-May.) 8000 w.

*32016. The Nicaragua Canal. Editorial (*Fairplay*-May 17.) 1600 w.

*32023. Compulsory or Voluntary Conciliation. Dr. Robert Spence Watson (*Ir & Coal Tr Rev*-May 17.) 4000 w.

*32026. Imperial Federation: Its Relation to British and Colonial Trade. Anon. (*Ir & Coal Tr Rev*-May 17.) 3000 w.

*32086. Progressive Individualism. John R. Commons (Am Mag of Civ-June.) 5000 w.

*32087. Is Monopoly Always Victorious? Gilbert L. Eberhardt (Am Mag of Civ-June.) 1600 w.

*32088. The Issue in Ninety-six. A. J. Warner (Am Mag of Civ-June.) 2700 w.

†32094. Power and Wealth of the United States. Michael G. Mulhall (N Amer Rev-June.) 2600 w.

†32096. The Silver Question. I. Germany's Attitude as to a Bi-metallic Union. Count von Mirbach. II. The Silver Standard in Mexico. M. Romero (N Amer Rev-June.) 5500 w.

32117. Deserts the Hot-bed of Populism (Soc Ec-June.) 2800 w.

32118. Ship Subsidies and Bi-Metalism (Soc Ec-June.) 1000 w.

32119. The Duty of Protectionists Towards Ocean Navigation. William W. Bates (Soc Ec-June.) 1300 w.

32120. The Gratuitous Benefactions of Capital. T. B. Stork (Soc Ec-June.) 4500 w.

*32121. The Growth of American Nationality. Francis A. Walker (Forum-June) 6800 w.

*32122. The Free-Silver Argument. W. H. Harvey (Forum-June.) 5800 w.

*32123. The Grotesque Fallacies of the Free-Silver Argument. J. DeWitt Warner (Forum-June.) 3400 w.

*32125. The Only Cure for Slums. E. R. L. Gould (Forum-June.) 2600 w.

We supply copies of these articles. See introductory.

MARINE ENGINEERING

Structural Weakness of Steamers.

A PAPER of unusual import, in view of the recent breakdowns of machinery—especially of shafts—on ocean steamers, was one recently read before the Institute of Marine Engineers at Stratford, England, by Mr. John McAllum, and reported in *Engineers' Gazette* for May. While it has long been believed by some, and disputed by others, that vessels deflect in loading, "it has been clearly demonstrated, despite the opinions to the contrary, that the forms of vessels do alter; and in the port of Cardiff, which offers special advantages in observing vessels which are constantly trading to and from the port, we have the evidence of those persons responsible for the loading, and who have ample opportunities of verifying their statements, that under different conditions of loading different weights are carried, water ballast and coal remaining in bunkers being allowed for. If we are to believe these statements, is it surprising to hear of detention and subsequent prosecution for overloading? In many cases there are doubtless evasions of the law, but in others the submersion of the disc is not entirely due to weight carried, but to the manner in which it was put in the vessels; and there is reason to doubt that the vessel has an excess of cargo over her usual complement."

Theories advanced in the past have attributed the failures of marine engines and shafts to bad material, bad workmanship, and faulty design; but the structural strength of the steamer, its deflection and working in a sea-way, is, the author contends, one of the main points of weakness. Particulars of a series of observations taken on board a steamer of 3000 tons net register, notorious for the breaking of her shafts, are given as follows:

"The vessel was well built and of a superior class; engines triple and well-balanced, both hull and machinery being constructed by first-class builders. On the second voyage one shaft broke, and within 2 years four lengths of shafting were either broken off or condemned, the material in every case showing itself solid at the fractures and of the best quality. The shafts were made of the best selected iron, and 20 per cent. in excess of requirements. Observations in the first instance were taken in the shaft tunnel by the engineer of the steamer, by means of a steel wire, 19 B. W. G., running parallel with and directly above the center line of shafting, one end of which was secured to the engine-room bulkhead, and the other conveyed over a small pulley, 6 in. diameter, acting in a suitable bracket, which was bolted to the after bulkhead in the tunnel, and the wire was kept taut by a weight of 46 lbs. suspended at the end. The distance from bulkhead to bulkhead was about 112 ft., and midway between a square graduated rod with a jaw end, in which a pulley acted, was brought into contact with the shaft and kept in the vertical position by means of two projecting brackets of light design, fastened to the tuunel sides, one above the other, and through which the graduated rod operated vertically, and any difference in the indications was easily noted.

"It may be urged that this method of determining the vessel's movement was crude and unreliable, and that the actual amount could not be estimated with sufficient precision; but, at the same time, it seems clear that, if there was no movement, the indications would remain unaltered. The difficulties which have to be overcome in taking observations in a tunnel are doubtless the principal reasons why we have no record of any; and, when we consider the unfavorable conditions in a dark and confined space in which a shaft is revolving, the method adopted by the engineer, with the means he had at his disposal, recommends itself as ingenious. The result of the observations was with ship loaded, draft 24 ft., with a heavy con-

fused sea on starboard beam and quarter, engines racing occasionally, and vessel lurching and pitching about 18 to 20 ft., a maximum movement of 1¼ in. vertically. This was the greatest deflection seen, happening invariably when the steamer's stern was high and the seas passing between Nos. 2, 4, and 5 hatches. The ordinary amount observed when the vessel was pitching in a head sea about 10 ft. forward was from 1¼ in. to 1½ in. No change took place when in port, for, as a rule, the holds were discharged together and loaded together. With engines stopped at sea, the wire resumed its normal position exactly as in port, and, on restarting and getting under weigh, the graduated rod indicated a deflection of ⅜ of an in. in smooth water, the vessel's stern showing a downward tendency which was attributed to the movement of the propeller."

Observations made on deck by means of sight confirmed the observations made in the shaft tunnel. In one experiment a downward deflection of ¾ in. at the stern was noted. "Working under these conditions of hull movement, a squeaking noise was heard in the tunnel; this was located in the after couplings, and, on this noise increasing, the engines were stopped for examination, when it was found that the coupling bolts were loosened, and the nuts could be tightened up one and a half panes more or less. On former occasions it was noted that the bolts had behaved in a similar manner, and for closer observations the nuts had been marked accurately on to the bolts, and the bolts were alike marked on the chart; so it was clearly evident that the bolts had elongated due to the strains set up through the vessel's movement. After the bolts had been carefully refitted, the trouble would cease for about 3 months. This steamer's hull was afterwards strengthened, and up to the present there has been no further complaint."

Flexible couplings and stiff springs under the tunnel blocks have been successfully used to obviate the bad effects of the deflection of hulls upon the machinery. In the discussion which followed, Mr. J. F. Flannery said that putting engines aft in tank steamers increased vibration and caused serious local strains upon the after part of the ship.

Water-Supply on Board Ship.

FOR insuring a fresh water-supply on board ship attention has been assiduously directed to the invention and designing of apparatus whereby sea-water can be made potable. As sea-water contains large quantities of soluble salts, the principal part of the problem has been to effect the separation of these salts from the water that holds them in solution. Thus far this has only been possible by distillation, the distillate being water and the salts remaining in the still.

A new and very effective apparatus for this purpose is described in *Transport* (April 12.) This apparatus differs from all the devices that have preceded it, and obviates the necessity of the brass or copper condenser-tubes hitherto employed. These have been a frequent source of trouble through scaling and corrosion. The formation of scale reduces seriously the efficiency of the condenser, and thus an apparatus which at the beginning may have been of ample capacity may prove to be deficient just at the time when it is most required; and, when it is put into service, it usually demands a great deal of cleaning and overhauling. Any apparatus which will obviate these drawbacks will be a welcome addition to marine appliances, and the claim is made for the new apparatus (called "The Henneberg," after its inventor) that it completely removes them.

"The condenser is formed by a number of plate elements which are provided on both sides with channels cast of special form. Between these elements are placed thin tinned copper sheets, which shut off the channels of one element from those of the other. The channels of the different elements, both above and below the copper sheets, are connected by pockets, cast on the side of the elements, and by this means two entirely separate systems of channels are formed, and kept asunder by the copper sheets already mentioned. If one of these channels is fed from above with steam, and the other from underneath is supplied

with cooling water, the steam—*viz.*, the vapor from the evaporator—and the cooling water are moved along, after the counter-current system, and in such a manner that an extremely rapid exchange of heat takes place between the two liquids. In such transformation the highest efficiency is secured in a comparatively small apparatus, and a refrigeration of the condensate is thus obtained which could not be secured in tubular condensers. The following data, which have been taken from practical working with the vapor at a pressure of 11 lbs. per sq. in., demonstrate the merits of the apparatus:

"(*a*) Cooling effect such that the difference between condensed drinking water and the cooling water entering the apparatus was only 25° Fahr. (1) Capacity per sq. ft. condenser surface, 80 gallons of drinking water per 24 hours. (2) 100 gallons of drinking water per hour are produced with a condenser; weight with water added, 42 lbs. (3) Quantities of cooling water, about 8 times as much as the condensate. Final temperature of cooling water, 194° Fahr.

"(*b*) Cooling effect such that the difference between condensed drinking water and the cooling water entering the apparatus was 5° Fahr. (1) Capacity per sq. ft. condenser surface, 134 gallons of drinking water per 24 hours are produced. Weight of condenser, weight of water included, 27 lbs. (2) Quantity of cooling water about 8 times as much as the condensate. Final temperature of cooling water, 194° Fahr."

These figures indicate great efficiency. They are said to have been taken from large installations. The superior efficiency over tube-condensers is doubtless due to the rapidity with which the cooling water circulates over the condenser-plates. In tube-condensers "the construction and design arrest the velocity of both water and vapor, thereby raising the temperature of the distillate, and to a great extent assisting in the deposit of salts and scale on the tubes, necessitating the constant cleaning of the entire apparatus, and entailing much trouble. Further, in comparing the weights of the different types with their efficiencies, it will be found that the plate system has a most substantial advantage. One of the most important, or what may be accepted as the most prominent feature in favor of the newly-introduced system is the perfect aeration of the vapor in its passage through the condenser. Owing to the violent process of condensation, and the rapid cooling of the condensate, all the air which is expelled from the sea-water is reabsorbed, and the water is produced as a clean, cool liquid, having all the qualities and ingredients of natural water, with a taste almost equal to that obtained from a spring or well. In tubular condensers such a product never can be obtained, as, even in spite of all the many recently-improved arrangements of aeration, the water gathered from tubular condensers generally tastes insipid." The new apparatus is stated to have been adopted in war vessels and transports, and a famous firm of marine engineers is now engaged in its manufacture.

The Defender.

THIS sloop yacht, designed to defend the cup against the English contestant that will be sent over to take it away, if possible, this summer, has been built under the impression that the coming contest will be the most severe yet experienced by American yachtsmen. Probably no sporting event of the year will so generally excite interest throughout the country as this, especially among naval constructors and marine engineers. Every effort possible will be exerted on both sides. It is not merely a race that will be involved, but the question of ability in marine design and construction as between America and England. *Scientific American* (May 25) describes the Defender probably as well as she can be described under the restrictions imposed.

"The exact measurements have not as yet been made public; for from the time of their conception until long after launching the cup-defenders have ever been mysteries to the public, and the present yacht is, if anything, more so than the preceding ones. This secrecy must be maintained, so as to keep the lines and dimensions from rivals and those interested in the

challenging yacht. The present figures, although in some instances unofficial, will probably be but little out when comparison can be actually made.

"The Defender is not far from 126 ft. over all, and between 80 and 90 ft. at the water line. The beam is about 23 ft., draught about 19 ft. She has no auxiliary center board forward, but is an out-and-out keel boat. She has a 35-ft. lead bulb weighing 60 tons. In the lead bulb of the Defender, Herreshoff has remedied a serious defect that existed in the Vigilant. Where the latter in a heavy sea pounded with her flat outside ballast, the Defender will rise and fall without pounding, as the egg-shaped form of her ballast gives easy entrance and withdrawal. The Tobin bronze plates, as used in the Vigilant, have been superseded by manganese bronze plates below the water line; and above it, as far as possible, they are of aluminum, with an alloy of about 10 per cent. of copper to resist corrosion and give added strength.

"Not only is the upper portion of the plating of the Defender of aluminum, but the deck beams themselves are of the same material, and the saving in weight over steel will be more than double the amount saved by the plating. The total saving effected by the use of the aluminum is estimated at seven tons, which is expected to tell greatly in favor of the Defender in the races. A dispatch from Boston states that the mast is 102 ft. long; topmast, 61 ft., 2 in.; spinnaker pole, 72 ft. These dimensions may be slightly decreased in fitting. It is said that the Defender will have 7000 sq. ft. of canvas in her mainsail alone, and her total sail area will be from 12,500 to 13,000 sq. ft. The distance from the deck to the hounds will be about 72 ft. The Defender's principal gain in sail area will be in the mainsail, the spinnaker being somewhat smaller than that of the Vigilant. One of the most interesting features of the Defender is the manner of working the sails. All the halliards will be led below, where they can be worked by means of powerful winches. The main sheet will also be led below, where it can be handled by a few men with the aid of a winch. Possibly the same may be done with the sheets of the head sails, but many of the details of the yacht are still kept secret. Much of the heaviest work of trimming sheets can be thus carried on below the deck, leaving the deck itself clear for other work."

A fancy sketch of the boat, as an artist has imagined she may appear, accompanies this description. It is pretty, but is, of course, merely a pictorial guess.

The Screening of Side Lights.

FAIRPLAY says that even among experienced seamen very loose and inaccurate notions appear to prevail as to the exact function performed by side-lights. The fact is the existing system has been accepted by the majority of seamen without any investigation. Side-lights have been supposed to project sectors of green and red light in a purely conventional manner which is well illustrated in the "Rule of the Road" by the late Mr. Thos. Gray, of the London board of trade. In that publication it will be seen that the rays emanate from a point. As a matter of fact, light issues from the lantern in a different manner altogether, and it is this difference between the conventional and the actual which lies at the bottom of the whole controversy. It is a well established optical principle that "every luminous body emits divergent rectilinear rays from all its points and in all directions." Applying this principle to ships' side-lights, we see that from every point on the luminous surface of the lens rectilinear rays diverge in all directions.

It will be seen that in the latter case the effect is to produce a sector of light extending over a larger arc than in the former case. The error which the nautical advisers of the board of trade and the majority of seamen have fallen into consists in regarding the rays as emanating only from the wick; the rays of course do so emanate, but they illuminate the lens, and it is the rays from the lens which meet the eye of the observer. We may say that the larger the lens the larger is the arc over which the direct and secondary rays extend. It is the presence of the lens which

makes it so difficult in lighthouse work to throw a sharply defined sector of light over a given area, or rather, the lens increases the difficulty of defining the limits of the sector. As an instance of this we may mention the Longships light. The writer has frequently noticed that when steaming past this light there is a considerable sector of overlapping red and white rays. Applying the foregoing principle to the case of ships' side-lights important conclusions follow. Sir Donald Currie speaks of a steamer whose lights were screened to the 4 degree angle: he said "the look-out man on watch on the forecastle head of that ship is unable to discern an approaching steamer, as he is blinded by the glare of red and green in advance of his ship." This will at once be recognized as a matter of first importance in marine engineering. How many accidents have resulted from improper screening of side lights it is impossible to say. Some cases wherein carelessness has been charged are explicable from the fact that people expected to see sometimes cannot see.

Current Leading Articles on Marine Engineering in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

31627. The American Naphtha Launch. Ill. (Am Shi-May 9.) 900 w.

31703. Screw Steamer and Steel Tow-Barge Efficiency. Joseph R. Oldham (Can Eng-May.) 2200 w.

*31754. Deviation of the Compass. A. W. Reinold, with Discussion (*Jour Soc of Arts*-May 3.) 5000 w.

*31760. Experiments in Connection with Evaporation. Ill. D. B. Morison (*Marine Eng*-May.) 6000 w.

*31761. Induced Draught as a Means for Developing the Power of Marine Boilers. W. A. Martin (*Marine Eng*-May.) 1000 w.

31806. The Marine Gasoline Engine and Gas Engine Boat. Ill. (Sci Am-May 18.) 900 w.

31808. The Layman Pneumatic Sporting and Outing Boat. Ill. (Sci Am-May 18.) 800 w.

*31820. Doxford's Boat-Lowering Gear. Ill. (*Eng Gaz*-April,) 600 w.

*31821. The Structural Weakness of Steamers and Its Influence on the Propelling Machinery. (Abstract.) John McAllum (*Eng Gaz*-May) 1500 w.

*31850. The Story of Shipbuilding on the Tyne (*Eng*-May 10.) 1300 w.

*31886. The Waterways of Germany (*Fairplay*-May 10.) 1600 w.

*31887. Lights in the Gulf of Aden. Anon. (*Fairplay*-May 10.) 900 w.

31947. The American Yacht Defender. Ill. (Sci Am-May 25.) 1000 w.

31949. Improved Boat-lowering Devices.—Suggestions of Commander Tupper (Sci Am-May 25.) 900 w.

*32000. Extension of Japanese Maritime Communications (*Bd of Tr Jour*-May.) 800 w.

*32005. Japanese Shipping. Editorial on paper by Francis Elgar (*Engng*-May 17.) 1800 w.

*32006. The Development of Naval Ordnance. Editorial (Engng-May 17.) 3000 w.

*32009. Stability of Tank Steamers. W. Hök (*Engng*-May 17.) 5000 w.

*32052. The Harbors of Cape Colony (*Trans*-May 17.) 1700 w.

32111. Leak Arresters for Ships (Sci Am Sup-June 1.) 1000 w.

32211.—$1.25. Laws of Similitude Regarding Questions of Naval Construction. J. A. Normand (Jour Am Soc Nav Eng-May.) 4500 w.

32213.—$1.25. Machinery of British War Ships. Ill. Albert J. Durston (Jour Am Soc Nav Eng-May.) 7000 w.

32214.—$1.25. Tubulous Boilers in the French Navy. John K. Robison (Jour Am Soc Nav Eng-May.) 17000 w.

*32241. Lighting the Magellan Straits (*Fairplay*-May 24.) 700 w.

*32243. The Screening of Side Lights. Ill. (*Fairplay*-May 24) 1700 w.

*32258. The Screw Propeller. Ill. W. C. Winterburn (*Prac Eng*-May 24) 3500 w.

*32262. Stern Tunnels of the Olympia. A Criticism and a Reply Thereto (Ind'y-June.) 2500 w.

*32264. Old River Engines. By an Old-Time Steamboatman (Ind'y-June.) 1700 w.

32296. The United States Battleship Oregon. Ill. (Sci Am-June 8.) 400 w.

32301. The New American Steamship, St. Louis (Sea-June 6.) 600 w.

*32351. Submarine Navigation (*Eng*-May 31.) 1100 w.

Serials.

16636. Marine Engine Design. Ill. (*Mech Wld*-Began Oct. 6, 1893—24 parts to date—30 cts. each).

30466. Protection to Agriculture and Shipping—The Lubin Proposition Considered by Our Shipbuilders (Sea-Began March 28—4 parts to date—15 cts. each).

31818. The Drawing Office. Ill. Archibald Denny (*Mech Wld*-Began May 10—Ended May 17-2 parts—30 cts. each).

32208. The New British Cruiser "Terrible." Ill. (*Engng*-Began May 24—2 parts to date—30 cts. each).

32353. Breakdowns at Sea W. Welbury (*Eng*-Began May 31—1 part to date—30 cts).

We supply copies of these articles. See introductory.

MECHANICAL ENGINEERING

Compressed Air in Foundry Work.

MORE and more are the uses to which compressed air, as a storehouse of energy, are extending. In one line of industry—foundry work—Mr. Howard A. Pedwick, of Philadelphia, in a paper read before The Foundrymen's Association in that city May 1 (*Iron Age*, May 9), suggests further useful applications of compressed air, "which will be found a giant in strength, and at the same time a clean, safe, and docile power to handle." The use suggested would entail some extra coal for plant, but "the average foundry work would not need a very extensive or costly plant. The compressor, which is the starting part of an installation, has to be considered. To avoid trouble and expensive maintenance, it is desirable to obtain a machine calculated to furnish the needed volume of air with as little power as possible. Then, too, since the air will be used intermittently, the machine is better adapted if automatic in its action, thereby dispensing with any attention other than oiling. This automatic action is controlled by the variation of air pressure, causing the machine to start up when the air is being used, and to stop when the desired pressure is obtained, thereby saving power, wear and tear, &c. Durability and simplicity must not be lost sight of, since around the average foundry there are not always available men to overcome the little tricks that a great many air-compressors are more or less subject to. The air supplied for foundry purposes, too, must be dry, so that exhausting from a hoist or other apparatus may not cause a miniature shower in the nature of spray. The larger types of machine often use water for cooling the air under compression in the compressing cylinder, which causes the exhaust to act thus objectionably.

"Cooling the air by a water-jacket around the cylinder is preferable, not only from the fact of having dry air, but because it avoids the danger of water getting into the cylinder and causing its destruction. Clearance between piston and cylinder-heads must be reduced to as little as possible, so as to eject all the compressed air at every stroke. Without doing so, the air, necessarily heated under compression, expands, and will not allow the cylinder to take in its full capacity of free air, thereby causing the machine to labor without result."

For foundry work Mr. Pedwick regards driving compressors by belts as preferable, on the ground of economy, to driving them directly by steam. But, unless provided with ample fly-wheel, a belt-driven air-compressor is a very jerky, uneasily-working machine, and our choice would be the direct steam-driven type. A store of compressed air in an ample reservoir in a foundry can be utilized in many ways. It can be used to great advantage for all the lifting of flasks, ladles, etc., requiring mechanical aids. Direct-acting cylinders running on overhead trolleys may be so employed, or horizontal cylinders transmitting power by wire ropes may be used. A jib crane actuated by a compressed-air motor is a very useful appliance. The sand blast, the application of which compressed air renders possible, is the best means of cleaning castings ever devised.

The pneumatic clipping-chisel "does vastly more and better work than several men can accomplish in the old way. This little tool weighs about 15 or 20 lbs. It is a cylindrical piece of steel bored out to receive the piston, which is also the hammer. A small valve, controlled by the air pressure, admits air on either end of the piston, causing it to reciprocate very rapidly and to strike a blow at every stroke. The chisel is placed on a shank projecting from the cylinder. A slight pressure of the hand holding the upper end of the tool admits air, which starts the hammer. Externally there is nothing moving; the chisel is kept in contact with the work, as if the operation were a pushing-off pro-

cess. The amount of work accomplished by this little air tool is surprising, and, where much hand chipping is done, opens a way to very materially reducing the cost and labor for such work."

Other uses suggested are the breaking of scrap and pig for the cupola. The discussion that followed the reading of the paper indicates that leading foundrymen are alive to the advantages set forth by Mr. Pedwick. President Schumann stated that his "company had recently put a sand-blast machine in their works, and, where formerly 2 hours were required in cleaning special castings, the machine did the work in 10 minutes. The only trouble with it was that the operator was trying to do everything with it, even trying to chip out the cores on 12-ft. columns. They were using it on large castings to dispense with the use of facing in the sand. They were using the sand raw on castings weighing as much as 5000 lbs. to 8000 lbs., and the castings ultimately developed a beautiful slate color; yet, when they came out of the sand, it would seem to be a question as to how the sand could be taken off them."

It was further brought out in this discussion that a pressure of from 80 to 100 lbs., by gage, had been proved the most advantageous for general foundry use. The cost of compressed air in lifting, etc., is more than that of steam, but its cleanliness, convenience, and other advantages are regarded as compensating for this increased cost.

How to Inspect Boilers.

IN "Hints on Boiler-Inspection" *Boston Journal of Commerce* (May 4) the following points are noted. First, there cannot, in practice, be a too frequent or a too thorough inspection. The opportunities for doing this without interference with regular work or with holiday recreation will always be few enough. At every opportunity, such as cleaning days, "prepare for a thorough inspection of your boilers, let there be one or one hundred. After removing all ashes and clinkers from the boxes, wash out the boilers, so that an always disagreeable job may be made as pleasant as possible. Next go inside, examine thoroughly the bracing, look for cracks or crow feet where strain comes between rivets, and see if the heating and cooling of the boiler has produced them. If one brace is broken or cracked, see if there are still enough to hold the head until such a time as it can be replaced with a new one, without shutting down. That done, examine the head closely, particularly at the turn of the flange, for checking, which are small cracks produced by any slight movement of the head. This being the short radius of the curve, they will show here first."

Whether these are formed or not should be recorded " for further reference. They are not considered as serious, unless extensive, in which case more braces is the general recommendation." Examine next the shell near the water-line. If corrosion has reduced the thickness of the plate, the remaining thickness can easily be determined by drilling, and the pressure that can be safely carried can be computed for the remaining sound metal.

Examine the scale to see whether it is of the hard, solid, insoluble kind, or of a porous spongy nature. In any case scale should not be allowed to accumulate, but the hard kind is the most dangerous. The remedy to be relied upon is watchfulness and frequent cleaning.

The safety valve, steam pressure, and water gages should all be thoroughly examined, and any defect found in the entire line of inspection should be reported in writing to the company in which the boiler is insured. " Going in over the grates, the condition of the furnace walls should be carefully noted, the circular seams over the fire should be examined for fire-cracks; if any are found, and they run back of rivet into plate, drill small holes at the end of the cracks and put in a rivet; this will stop the crack from extending. If simply a fire-crack is found that is from rivet hole to edge of sheet and showing no signs of leakage, it in itself is not serious, but a note should be made of it for future reference.

" Going back over the bridge wall, which should not be too close to the boiler-shell, examine the flues or tubes for a possible

leak. If any are found, see what caused them. If there is any accumulation of scale around the tube end, remove it, roll the tube, and proceed with the examination. Examine the blow-off pipe, especially close up to flange or reinforce-plate on the boiler. A small leak here will soon cut through the pipe and give trouble; and it may, by blowing off, burn the fireman or cause a shut-down at an inopportune time. Should a defect be found which leaves you in doubt whether it would be safe to run, bear in mind that an explosion will cost more than a shut-down, and an error of judgment that shuts the plant down will not cost many lives, while an error in the other direction may."

Long-Distance Power Transmission.

"COMPARATIVE Cost and Efficiency of Electricity and Compressed Air for Transmission of Power to Long Distances" is the title of a pamphlet of 29 pages, 6" × 9", written by Prof. Herman Haupt, consulting engineer of the General Compressed Air Company, New York city. As these two methods of transmitting power over long distances are the only ones practically available, and as both are in use, although electricity has, so far, taken the lead, the subject is of immediate importance and interest to mechanical engineers. We are witnessing the infancy of an era of power-transmission from central sources over wide areas. Whether electricity or compressed air shall ultimately become the most favored mode of transmission, doubtless each will continue to have special advantages for special sets of conditions, as is the case with the cable and electric systems of car-propulsion; and both are present and future mechanical resources by no means near the end of their development, but still calling upon inventive skill for further perfection of mechanical appliances.

In our department of improved machinery is described an improved air compressor, showing features of novelty that suggest yet unopened leads in which development may advance.

Prof. Haupt quotes from an article printed in the *Boston Herald* (Feb. 1), not naming the author (stated to be an electrical expert), who writes referring to a previous article in the same newspaper.

The previous article had stated that "the consensus of expert opinion was that, at the present stage of science, when so little was known" and so much yet to be learned, "the transmission of electrical energy from Niagara Falls to distant points could be accomplished only at such a loss of power that it would prove a commercial failure."

"The writer claimed that, 'until dynamos capable of generating currents of at least 20,000 voltage were invented; until the expensive transformers were done away with; until friction could be reduced to a minimum, and induction largely eliminated,—electricity could not be sent over 5 miles and delivered in successful competition with steam. Within a year from the time this was written these opinions were substantiated and admitted by the Niagara Falls Power Company, and by Tesla himself.'

"The Niagara Falls Power Company made application to the city of Buffalo for a franchise to deliver power in that city, but, being required to name conditions as to time, price, etc., the company was forced to say that 'it cannot name a price for electrical power transmitted to the Buffalo city line, as in the question of transmission are involved the uncertainties of the losses and cost of operation and maintenance.' This has ended all questions of supplying distant points, at present, with electricity from the falls. Last week the New York *Herald* announced that Tesla states that it would probably be too expensive and wasteful to attempt to transmit large electrical energy by ordinary alternating currents."

Siemens, Edison, Unwin, are quoted to substantiate the proposition that the commercially practicable limit of electric power-transmission is about 5 miles. On the other hand, Mr. Franklin Leonard Pope, electrical editor of this magazine, is quoted as having stated with reference to a power-plant installed under his design and supervision at Great Barrington, Mass., that, from results there attained, he

thinks the Boston *Herald* writer is in error, and that power can be transmitted 20 miles from a turbine and compete commercially with steam-engine power at that distance.

This opinion is attacked by Prof. Haupt, who makes a calculation to show that power transmitted 20 miles from turbines, even with a voltage of 5000,—which Mr. Pope declares he would not hesitate to use,—would cost more than twice as much as steam power generated *in situ:* and he concludes that, unless voltage can be practically "increased much beyond 5000, the idea of electrical transmission to long distances must be regarded as an *ignis fatuus* beyond the possibility of attainment at any cost commercially justifiable."

Now, as to transmission of power by compressed air, the following points are held to be established. (*a*) That ignorance and prejudice have retarded the use of compressed air for power-transmission. (*b*) That, by reheating compressed air, it can, at small expense, be made to yield more power in a motor than it takes to compress it to a given working pressure. Hardie's new air motor, which at Rome, N. Y., has achieved a marked success, is cited as proof of the latter statement. This motor provides for reheating the air before inducting it to the motor cylinder by passing it through a hot-water heating device which increases its volume 100 per cent. under constant pressure, the air being thus heated to the temperature at which steam is ordinarily used and at the same time absorbing about 1 lb. of steam for each 50 cu. ft. passed through the water.

The total of these accessions is stated to be 100 per cent. The increase of volume in the compressed air from reheating alone is said to be fifty per cent. Of course the truth of the latter statement can easily be proved or disproved by resort to mathematical methods. The fact that 50 cu. ft. of air, compressed to 2000 lbs. per sq. in., as in the Hardie motor, will absorb 1 lb. of steam can only be proved by experiment; but, assuming this datum to be correct, the increase in volume due to such absorption can also be determined by the mathematical application of thermodynamic principles. It is not likely that a statement so open to challenge would have been made without knowledge that it can be sustained.

A calculation of the cost of transmitting power 20 miles by compressed air is next presented, and another of the cost of transmission 100 miles, each through 6-in. pipes, the initial pressure being 2000 lbs. per sq. in.; and the conclusion is reached that, even at 100 miles, there would be a slight difference in favor of compressed air over steam-power locally generated, when large turbines are the prime motors. The author concludes his essay with the following significant paragraph:

"Finally, if power should be generated at the coal mines by the use of refuse coal, costing nothing, and transmitted 100 miles in pipes, the cost of the power for 2500 horse-power would be as follows:

"Interest, repairs, and depreciation of the boiler plant, $9375; wages of firemen, $2700; interest and repairs of compressor-plant, $12,000; interest on pipe-line, $15,000; wages of engineers, $4000; total, $43,075; or $17 per horse-power per annum, which would be nearly $10 less than cost of steam-power generated locally."

Experimental Engine Built at Sibley College, Cornell University.

IF any proof that the steam-engineering course of study in Sibley College is in the highest degree efficient had hitherto been lacking, it would have been supplied by the experimental quadruple expansion engine, designed by Messrs. Thomas Hall and C. H. Treat, students in that institution, of which Prof. R. H. Thurston is the head. Whatever criticism of this engine may be indulged in, it must be conceded that its design shows a profound knowledge of fundamental principles. It also evinces much inventive and constructive talent. The statement that this engine develops 1 h. p. for less than 10 lbs. of steam challenges belief, as the very best previous record belongs to the Milwaukee pumping engine,—11.67 lbs.

Power for June contains a long illustrated description of the engine. We shall

endeavor, in this review of that description, to present a general idea of the machine, though it is impossible, without illustrations, to deal much with details.

"The engine was built in the Sibley College shops, Cornell University; it was designed for an experimental engine, the principal objects of experiment being to find how the economy increases with steam pressure and with speed of rotation. It involves several new features. An entirely new form of valve gear was designed, the prospective high speed of the engine rendering necessary a novel departure in this line. In order to generate the high pressure steam required, a boiler has been built in which it is possible to carry 1,000 lbs. steam pressure; and a special form of brake was designed capable of keeping the load automatically constant. The principal considerations in the design of the engine were, first, that its construction require as little labor as possible, for at best it was to be a large undertaking; second, that it should attain the highest economy after providing for rapid construction."

The means of reducing wastes in steam engines, available to designers, are: "(1) increasing the number of cylinders, and so reducing the range of temperature in any one cylinder; (2) making internal area a minimum, and coating with non-conducting material; (3) jacketing; (4) superheating; (5) high rotative speed."

The design was worked out with reference to a maximum pressure of 500 lbs. This corresponds to a temperature of 467° F. To prevent waste of heat through the escape of fuel gases at and above this temperature, these gases are made to reheat the steam between stages of expansion, passing to receivers serially from those of higher pressure to those of lower. The cranks are at 80° angles, which very closely balance the entire machine. In fact, it is stated that it was run at five hundred revolutions per minute, while simply resting on blocks without being rigidly bolted to anything. The stated low friction loss—10 per cent.—is also surprising for a four-cylinder engine.

A feature showing the inventive skill of the designers is the construction of the induction valve and valve gear. "The steam valves admit through a slot in center, when the slot is over the port. Steam is admitted by one edge of the slot and cut off by the other. These events occur at each stroke of the valve, and consequently the motions of the steam gearing need be only half as frequent as ordinarily, thereby reducing the inertia effect to one-fourth. Spiral gears in the base give this reduction of speed, and drive a short shaft, having cranks instead of eccentrics to transmit the motion to a sliding block movement at the front of the engine. This device operates to give the valves quick movement during the admission period, and reduces over-travel of the valves." This valve gear is ingenious. The exhaust valves are much like the Corliss, and driven by a crank on the end of the shaft. Indicator diagrams taken from these engines show excellent induction and compression lines. The release is uniformly good, in all the cylinders, and the exhaust lines follow very closely the theoretical pressure lines at the end of each expansion. The valve action is therefore much more perfect than is frequently the case in quadruple expansion engines.

Working Stock in Drop Dies.

THE use of drop-forging in machine-construction increases yearly. New machines for all sorts of purposes are coming into existence, and so the desired uniformity and cheapness of production in those involving much duplication of wrought-metal parts is, in the majority of cases, obtainable only by this method. A good practical discussion of the subject of "Working Stock in Drop Dies," by B. F. Spalding, is contained in *American Machinist* (May 16).

The relation which the cost of the dies bears to the cost of a given number of forgings will determine the adoption or non-adoption of the method, except in cases where uniformity is essential, and wherein this is the cheapest and surest method of obtaining such uniformity.

"When it becomes evident that a large number of pieces is to be made, and that the tools for making them will require fre-

quent renewal, it becomes a matter of economy to provide reasonable facilities for the reproduction of these tools, and also to fix the methods which shall be adopted for the use of the tools, so as to insure their utmost effectiveness and durability, and restrict within the narrowest limits the expenses of profitless manufacture. On drop work, for instance, it is to be determined what sized drop shall be used, and how many blows shall be struck at each operation. Drop dies, therefore, come well within the scope of the rule. They are quite expensive in both material and workmanship, and are often subjected to the handling of piece-workmen, who are naturally a good deal more interested in getting all they can out of them, in the shortest possible time, than they are in their preservation. It is true that drop-hammer men soon become shrewd enough, as a general thing, to know that, the better care they take of their dies, the easier and more freely they will work; but, as they stand with a piece of work in the die, which is not quite filled out with the blows already struck upon it, there is but an instant afforded them in which to decide whether it is best to give the cooling piece one blow more without reheating, and in that critical moment they are liable to be overcome by a surge of self-interest, and decide to hit it again and risk the die."

The ways in which dies may be injured in use are indicated. "A hot piece of iron might lie loosely in the impression of a die till it cooled. It could become cold without heating the corners around the impression enough to seriously affect their temper; but it is quite a different thing when the hot iron has already been struck with such force as to bring it into more intimate contact with the steel of the die than its own grains have with each other; for the steel has the heat absolutely forced into it when an additional blow is given. If this will not draw the temper, nothing will, and, if the corner of the impression is already almost red-hot, then the additional blow, driving down on the almost cold fin, will drive the corner and make it overhang and hug the work so that it will be hard to disengage it from the die. Then the good hammer-man, if he is not unmindful of the future, will have the die fixed before it gets any worse; but, if his temper rises when that of the die falls, he will continue to devil with the die until his work sticks so bad that, in removing it, it gets out of shape so much as to damage it. Then he will have the die repaired."

Mr. Spalding thinks that, notwithstanding some objections to heavy drops which he names, it is, as a general rule, better to use a force sufficient to press the hot metal into all parts of the die at one blow, especially in cases where "the especial economy of the dies" is a ruling consideration; but the striking of more than one blow improves the forging. When, then, the highest obtainable quality in the forging is the ruling motive, it is better to use lighter blows and repeat them till the hot metal fills the die. As a rule, however, stock can now be obtained that will give good forgings, whether forged by one or more blows, so that the improvement of the stock in the process of drop-forging is almost eliminated from modern practice.

A caution against unquestioning reliance upon "fair outsides" in judging the quality of drop-forgings is given. A very poor forging may look very well as it comes from the dies, but, notwithstanding, may contain cold shuts and imperfections. If drop-forgings do not possess desired qualities of strength, etc., "some revision should be made of the processes, and such corrections made as may have a favorable effect." When welding is to be done in dies, it should be done at a single blow. If more blows are used, there is danger of imperfections in the weld. Any part that does not weld at the first blow will scarcely unite by repetition of blows.

"If the dies are properly devised and the work is carefully manipulated, the material in a drop-forging can be brought to the highest degree of excellence which stock is capable of possessing. The stock can be wrought in drop dies to its greatest perfection without much injury to the dies. Stock allowed to cool from a welding heat, with no work done upon it below that heat, is very far from being in its best condition."

Soundness of Castings.

MR VON RIET has adopted the plan of fixing a separating chamber above the flask. This chamber is divided into three circular compartments. The molten metal is poured into the largest in such a way as to give it a whirling motion, which causes the heavy metal to keep to the sides, whilst the lighter scoria remains in the centre. A communication to the second compartment is made at one side, and here a further separation is effected, the purified metal escaping finally into the third compartment, in the middle of which is the pouring hole to the flask. In this way sounder castings are obtained.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Mechanical Engineering in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

The Machine Shop.

31813. Working Stock in Drop Dies. B. F. Spalding (Am Mach-May 16.) 2000 w.

32142. Another Remarkable Broaching Job —A Limit Gage for Worm Threads. Ill. (Am Mach-May 30.) 900 w.

Steam Engineering.

31244. Hints on Boiler Inspection. Charles H. Garlick (Sta Eng-April.) 1200 w.

31711. Burning Coal Economically. With Special Reference to Small Sizes of Anthracite. (Extracts) Eckley B. Coxe (Bos Jour Com-May 11.) 2400 w.

31712. Superheated Steam—Some Remarks Concerning Its Economy (Bos Jour Com-May 11.) 1200 w.

31815. Setting Corliss Valves. Ill. (Am Mach-May 16.) 1800 w.

31846. The Smoke Question. Editorial (Am Mfr & Ir Wld-May 17.) 700 w.

31885. Hints about Injectors for the Engineer and Fireman. Ill. Anon. (Tradesman-May 15.) 1200 w.

31889. Auxiliary Stopping Devices for Steam Engines.—The Great Value They Would Be to Steam Users. E. C. M. (Bos Jour Com-May 18.) 1800 w.

31890. Pipe Coverings—A Test of Their Efficiency (Bos Jour Com-May 18.) 1000 w.

31945. Feed Water Heating. W. H. Booth (Am Mach-May 23.) 1400 w.

*32007. The Willans Engine. Report of paper by Mark Robinson (*Engng*-May 17.) 3300 w.

32105. A Gravity Return System for Utilizing Water of Condensation. Ill. Safety V-May 15.) 1700 w.

*32202. Steam Engine Problems. Editorial (*Eng*-May 24.) 1400 w.

32212—$1.25. The Determination of the Dryness of Steam. Ill. W. Cawthorne Unwin, with Discussion (Jour Am Soc Nav Eng-May.) 9800 w.

32250. Wastes from Boiler Management. R. C. Carpenter (Mach-June.) 2000 w.

32251. Boiler Heating Surface. Conrad Skarstedt (Mach-June.) 1000 w.

32267. Steam Jackets and Superheating (Bos Jour Com-June 1.) 2000 w.

32286. A Remarkable Engine. Ill. Designed by Thomas Hall and C. H. Treat (Power-June.) 3800 w.

*32386. The "Stephenson" Link Motion. Ill. G. R. B. (*Mech Wld*-May 31.) 800 w.

Miscellany.

*31630. New Methods of Connection for Power Transmission. Ill. E. Hoegerstaedt (*Mech Wld*-May 3.) 700 w.

*31650. The Gigantic Wheel (*Engng*-May 3.) 1200 w.

†31671. Furnace Draught. From Indian Textile Journal (*Ind & East Eng*-April 6) 1100 w.

*31694. Belt and Rope Transmission Trials (*Elect'n*-May 3.) 3300 w.

31705 Safety Valves. W. G. Blackgrove (Can Eng-May.) 1700 w.

*31771. Process of Manufacturing Leather Belting. Ill. (Milling-April.) 1000 w.

31799. Graduations for the New Decimal Gauge. Oberlin Smith (Ir Age-May 16) 2000 w.

31804. A Recent Supreme Court Patent Decision—Ridson Locomotive Works vs. Medart (Elec Wrld-May 18.) 4000 w.

31809. Bessemer, the Inventor, and his Treatment by the Britishers. From Boston Commercial Bulletin (Sci Am-May 18.) 1600 w.

*31817. Belting (*Mech Wrld*-May 10.) 1700 w.

31832. The Friction of Wood upon Wood at High Pressures. Ill. Edwin A. Messiter and Richard C. Hanson (Eng News-May 16.) 1500 w.

*31833. Eli Whitney: A Shakespeare of Invention (Self Culture-May.) 3000 w.

31839. Review of paper by W. H. Pfahler on "Foundry Costs" (Ir Tr Rev-May 16.) 1800 w.

*31873. The Economics of Coal. Editorial (*Engng*-May 10.) 2500 w.

31888. Machinery and Labor.—Methods of Investigation of Its Effects by the Labor Department (Bos Jour Com-May 18.) 700 w.

*31903. Fuel Testing Stations. E. G. Constantine (*Prac Eng*-May 10.) 1000 w.

31933. Density Affected by Compression. B. F. Spalding (Age of Steel-May 18.) 700 w.

We supply copies of these articles. See introductory.

31954. Brake Test of Gas Engines at Danbury, Conn. Anson W. Burchard (Ir Age-May 23.) 2300 w.

*31956. Test of a 500 H. P. Triple Expansion Engine. S. G. Colt and J. B. Mitchell (Sib Jour Eng-May.) 1500 w.

31974. Half a Century of Cycles. Ill. From the London Daily Graphic (Sci Am Sup-May 25.) 3300 w.

*32017. Coal-Unloading Arrangements by Savon Freres, Marseilles. Ill. (*Col Guard*-May 17.) 1500 w.

*32028. Patching Up Defects. G. C. Henning, in Cassier's Magazine (*Ir & Coal Tr Rev*-May 17.) 2500 w.

*32030. The Second Law of Thermodynamics. Oliver J. Lodge (*Elect'n*-May 17.) 6000 w.

32081. Various Uses of Compressed Air (Age of St-May 25.) 800 w.

†32090. Modern Calorimeters and Their Use. Ill. Joseph Struthers (School of Mines Quar-April.) 5500 w.

32106. Trial of a Schmidt Motor (Boiler Superheater and Compound Engine.) M. Schroter. Summarized by Bryan Donkin (Safety V-May 15.) 3000 w.

32179. Aboriginal Handicraft in Stone. Gerard Fowke (Archæologist-June.) 3400 w.

32231. Mechanical Forces. C. R. Tompkins (Age of St-June 1.) 1500 w.

*32257. Ball Bearings. Ill. W. H. Booth (*Prac Eng*-May 24.) 2200 w.

32287. Riveted Joints. C. W. Mac Cord (Power-June.) 1800 w.

32308. A New Air Compressor. Ill. (Eng News-June 6) 1100 w.

*32354. Power Generated by Gas Engines Working with Producer Gas and Distributed Electrically.—Summary of a Report by Captain Leneveu (*Col Guard*-May 31.) 1900 w.

*32359. Furnace for the Rational Burning of Coal and Coke Dust and the Residue of Coal-Washing (*Col Guard*-May 31.) 1100 w.

†32394. The Manufacture of Insulated Wire. John E. McGregor (Ind Rub Wld-June 10.) 1000 w.

32398. Comparitive Cost of Electricity and Compressed Air for the Transmission of Power to Long Distances. Herman Haupt. 8000 w.

Serials.

13033. Practical Hints to Boilermakers and Templaters. Ill. (*Mech Wld*-Began May 12, 1893—18 parts to date—30 cts. each).

13534. The Gas Engine (*Mech Wld*-Began June 2, 1893—15 parts to date—30 cts. each).

16781. Rope Driving. J. J. Flather (Elec Wld-Began Oct. 26, 1893—19 parts to date—15 cts. each).

17823. Designing Corliss Gears. Ill. James Dunlop (*Prac Eng*-Began Nov. 24, 1893—11 parts to date—30 cts. each).

18044. Motive Power and Gearing. Ill. E. Tremlett Carter (*Elect'n*-Began Dec. 1, 1893—35 parts to date—30 cts. each).

24930. Some Notes for Enginemen and Firemen. W. H. Booth (*Elec*-Began Aug. 31, 1894—19 parts to date—30 cts. each).

25528. The Designing and Construction of Modern Steam Engines. Theodore F. Scheffler, Jr. (Mach—Began Oct., 1894—9 parts to date—15 cts. each).

27633. Engine Governors and Governing Mechanisms. R. Gordon Blaine (*Mech Wld*-Began Dec. 7, 1894—9 parts to date—30 cts. each).

30216. Care and Maintenance of Machinery. "Quirk" (Tradesman-Began March 15—6 parts to date—15 cts. each).

30555. The Proportions and Movements of Slide Valves. W. D. Wansbrough (*Mech Wld*-Began March 22—4 parts to date—30 cts. each).

30875. Fuel Oil. Comparative Results in Steam Generation. Clayton O. Billow (Elec Engng-Began April—2 parts to date—15 cts. each).

30971. Gas Power in the American Market. Ill. (Pro Age—Began April 15—4 parts to date—15 cts. each).

31095. Method of Initial Condensation and Heat Waste in Steam-Engine Cylinders. R. H. Thurston (*Ind & Ir*-Began April 12—Ended April 26—3 parts—30 cts. each).

31380. The Birth and Commercial Development of the Gas Engine. James Schleicher (Pro Age-Began May 1—Ended June 1—3 parts—15 cts. each)

31413. Old Master Mechanics. Extracts from a Lecture by John Richards (Ind'y-Began May—2 parts to date—30 cts. each).

31652. The Development of the Experimental Study of Heat Engines. W C. Unwin (*Engng*-Began May 3—Ended May 10—2 parts—30 cts. each).

31655. The United States Naval Gun Factory at Washington, D. C. Ill. (*Eng*-Began May 3—Ended May 10—2 parts—30 cts. each).

31763. Thermo-Dynamics. W. C. Popplewell (*Prac Eng*-Began May 3—3 parts to date—30 cts. each).

31944. The Shops of W. F. and John Barnes. Ill. John Randol (Am Mach-Began May 23—3 parts to date—15 cts. each).

31946. Cheap Fuel. Eckley B Coxe (Am Mach-Began May 23—Ended May 30—2 parts—15 cts. each).

32143. Grinding with Emery and Corundum Wheels. C. H. Norton (Am Mach-Began May 30—2 parts to date—15 cts. each)

32260. Riveted Water Pipe in the United States. Harold Jeans (*Eng Rev*-Began May 20—1 part to date—30 cts).

32328. Some Thoughts on Machine Design. De Volson Wood (Am Mach-Began June 6—1 part to date—15 cts).

32330. Modern Economy in Steam Engines. W. Arnold (*Prac Eng*-Began May 31—1 part to date—30 cts).

MINING & METALLURGY

Third Report of the Alloys Research Committee.

AN elaborate series of experiments on the composition and behavior of alloys has been conducted by the alloys research committee of the British Institution of Mechanical Engineers, and the latest results and conclusions are now given out as a third report by the chairman, Prof. W. C. Roberts-Austen, the well-known metallurgical authority. The investigation has gone into details of refinement which cannot be indicated here, and the reader is referred for precise information to the report itself, which is published in the *Iron and Coal Trades Review* (May 7) and *Industries and Iron* (May 3). The topics discussed in the present report are molecular porosity; increased sensitiveness of pyrometer; cooling curves of electro-iron, and of aluminum-copper alloys; iron-aluminum alloys; welding of iron and steel; anti-friction metals; etc.

Among the general conclusions reached are some regarding the strength of metals and alloys, which are of much interest. Prof. Roberts-Austen credits Pictet with having pointed out, in 1879, that there must be a connection between the melting points of metals and the periodic law of Mendeléef, since for all metals there is a simple relation between their atomic weight, the amplitude of their molecular vibrations under the influence of heat, and their melting-point. Pure metals with high melting-points—such as platinum, iron, copper, and gold—are comparatively strong; and conversely metals with low melting-points—zinc, lead, cadmium, bismuth, and tin—are relatively weak. Metals with high melting-points must necessarily be coherent and tenacious, because much *heat* is required to drive their molecules apart in reducing them to the liquid mobile state in which their molecules have little coherence; and therefore at ordinary temperatures much *force* must be applied to overcome the cohesion of the molecules and break the mass. Conversely in metals with low melting-points a small elevation of temperature will overcome the molecular cohesion and render them liquid. Such metals are weak, because, if little heat is required to melt them, less force will be required to tear them apart. Hence melting-point and tenacity are closely connected.

The experiments on the alloys of copper and tin and a series of cooling curves of the copper-nickel alloys support the view that there is an intimate connection between the melting-point of an alloy and its mechanical properties. This connection, which is well marked at ordinary temperatures, becomes of great importance in the case of alloys that have to be subjected to more or less heat in industrial use.

It is shown that the majority of alloys have more than one solidifying point, and it is necessary to ascertain which of these points is the important one in relation to mechanical properties. The presence of a trace of metals with a large atomic volume, and consequently low melting-point, renders the mass brittle and unfit for mechanical use. Weakness is here associated with the low subsidiary melting-point. The action, however, of traces of impurities on masses of pure metal is very different from the effect of two metals on each other when alloyed in more or less equal proportions. In the latter case the temperature of the main freezing-point appears to be the more significant factor. The problem is a complex one, but Prof. Roberts-Austen believes that the increased sensitiveness which has now been given the recording pyrometer renders its experimental solution more hopeful.

Sulphuric-Acid Making from Gold Ores.

A PLAN which has long been discussed, but which, we believe, has not hitherto been put into successful operation,—namely, the utilization of the sulphurous gases formed in roasting gold-bearing pyrites for making sulphuric acid,—is

about to be tried on a commercial scale at Blacksburg, S. C. The pyrites used in existing sulphuric-acid works in this country can hardly be termed gold ores, though, like almost all pyrites, they sometimes contain traces of gold. A correspondent of the *Manufacturers' Record* furnishes a description of the works now being built at Blacksburg. He explains that the critical question is whether the gases, on leaving the roasting furnace, are rich enough in sulphur dioxid to be worth saving; that is, not requiring an extravagant condensation space and attendant expense. The usual roasting furnaces require a large excess of air for oxidizing; but he claims that a mechanical furnace has been devised (and will be used) to completely desulphurize the ore and at the same time leave the fumes in good condition for making acid. The gases are to be drawn from the furnaces through flues, in the ordinary manner, to the lead chambers, passing on their way through a niter oven supplied with sodium nitrate and sulphuric acid, the resulting gases intermingling and passing to the chambers, where they come in contact with steam, in accordance with the usual reaction process. Hecker and Gilchrist pipe columns will be used in connection with the chambers, by which a large reduction of space and expense is expected to be secured. There will be four chambers, with a capacity of 90,000 cu. ft., and six of these columns, with coke tower and all latest improvements. The plant will handle 10 tons of pyrite concentrates per charge. The acid is to be run by gravity to a fertilizer plant, there to be used in making acid phosphate.

The Crystallization of Steel.

THE animated agitation of the old question whether iron and steel, by repeated jarring and stresses, become "crystallized," and thus change from the fibrous or compact structure to one admitting of fracture under strains far below those sustained by the same metal in tests before service, is not at an end yet. Now the *Railroad Gazette* makes a suggestion that will clear the subject of one source of confusion of ideas,—the use of a term which in itself implies the explanation of breakages at abnormally low stresses. It proposes to get rid of one stumbling-block by dropping the word "crystallization" when speaking of metals broken in service (for this is a matter of degree only, from the minute crystallization detected only under the microscope up to the coarse granular or macrocrystalline structure), and substituting "fatigued" or something else more descriptive of the fact. The *Gazette's* idea is not a mere evasion of the question, but is intended to eliminate a snap explanation. It does not in any way discourage the most thorough investigation of all the physical properties of metals as examined in test pieces and again after rupture. More thorough study of facts and less theorizing are evidently needed.

The "Indicator" Feature in Some Gold Occurrences.

IN the famous Ballarat gold field of Victoria, Australia, the course of mining in early times followed the same lines as in the same period and later in other gold districts,— beginning with the surface placer, or "alluvial" (as it is locally called), and afterward extending to the working of veins. In time it was noticed that a class of stringy, irregularly-shaped quartz occurrences in soft slates meant greater richness in the "alluvial," and, when the shallow alluvial became worked out, the miners turned their attention to the quartz in place. After they had reached a depth where the country was less oxidized, the quartz occurrences in a certain band of slates and sandstones were found to be associated with a pyritic sheet (varying in thickness from 1-8 in. to about 1 in.), in the neighborhood of which, and also in the pyritic seam itself, were found the richest concentrations of gold. This pyritic seam became known as "the indicator." Subsequently a number of similar seams of pyrite, having more or less connection with the best gold ground, were found in the district, and were given characteristic names.

Mr. William Bradford, of Ballarat, has lately communicated to the Australasian

Institute of Mining Engineers a paper describing "the indicator" and its congeners. As to their origin, the author says: "To my mind the 'indicator' quartz formations appear to be due to the same class of causation as was instrumental in forming the larger quartz occurrences known ordinarily as lodes. . . These 'indicators' are in most cases mineral segregations in main fissures." The principal minerals of the "indicators" are pyrites, galena, and blende, and "it appears as if the most favorable situations for the deposition of [free] gold are the most favorable for the deposition of the iron, lead, and zinc; and all minerals are apt to take the slightest excuse in the form of a ledge, or pocket, or floor of any kind, for their deposition." Mr. Bradford cites a few of the many well-known occurrences of a similar nature, where, instead of being in a wide, defined lode with plain walls, gold is found in and associated with thin stringers of pyritic minerals; and he proceeds to extend the observations into a generalization, saying: "Since it appears that the 'indicator' feature of gold and quartz occurrences is due to the fissuring of certain parts of the mineralized strata, I have no doubt that it is present, and in the form in which we know it, in all quartz-mining fields all the world over." That is a rather sweeping assertion, and is not borne out by the facts so far as observation goes, for there is an indefinite variety of segregated deposits. But there is a good deal in the author's conclusion that "as miners we have been devoting too much attention to 'big main lodes.' Experience teaches; and I have no doubt that the stringy, spur-like formations of quartz, especially where associated with pyrites veins ('indicators'), will receive more attention."

Alteration of Coal Due to Subsidence at a French Colliery.

In May last a sudden disruption of strata, amounting to a small earthquake, occurred at the Montrambert colliery, Loire, France, producing an unusual crushing effect upon the coal. The phenomenon is described by M. E. Coste in the *Annales des Mines*, and a translation of his paper appears in the *Colliery Guardian* (May 3). It seems that the working area is about 2200 ft. long, and the seam, which is quite regular, averages about 5 ft. at one end and 3 ft. 6 in. at the other. Immediately above the coal is a thin false roof of shale impregnated with coal, varying in thickness, but not exceeding 20 in., and filling the inequalities of the true roof, which is a thick bed of solid sandstone. On the floor is another, but thinner, bed of sandstone, and between it and the coal is a false floor of clayey sandstone of variable thickness,—taking the place of the typical fireclay. The stalls had been carefully packed, but the roads leading to them were not fully gobbed. Loud detonations have been sometimes heard, tolerably rare as the lower portion of each panel is being worked, but becoming more frequent as the working advances. In 1888 a sudden displacement occurred to either the roof or floor of the seam, causing a shock that was felt for a considerable distance. The noises recently heard were attributed to the fracture of the floor, and they often corresponded with shocks sufficient to throw down the props. On May 5, 1895, a very severe shock occurred, cracking the timbers and accompanied with a violent rush of air. Fortunately nearly all of the miners were out of the workings at the time, but most of the lights of the few men in the roads were blown out, and the men thrown about. Inspection showed that the roof and floor were much nearer together than before, the false roof having fallen in, and in places the roads were blocked and the stalls nearly filled. In the disturbed area all the cleavage planes of the coal were opened, and the coal was so tender that a mere touch brought it down, and a thick cloud of dust was formed, which had not been the case before. A small bed of very fine coal dust was found next the floor, which did not previously exist. Everywhere the coal was found to be in a crushed state and very friable. The commotion was felt at the surface.

The author concludes by observing that, if similar fractures of roof or floor can cause such serious effects in a non-fiery mine, they might provoke far-reaching ac-

cidents in those where firedamp is present. A sudden disengagement of all the gas from the crushed coal would take place, and also that contained in the goal and in fissures in the roof and floor would be liberated, while the rush of current would prove a severe trial to most safety-lamps. It might be added that the dust formed in the disturbance would add a further dangerous feature.

The Mines of Nevada.

ACCORDING to "Dan de Quille," who writes to the *Mining and Scientific Press* (May 11), the mining industry of Nevada is now narrowed down to the working of gold properties,—gold-bearing quartz veins and the few scattered placers. "No mines are now being worked for silver alone; it will not pay to mine silver at present anywhere in Nevada at its price as a commodity. . . . Here and there bonanzas are found that are so rich that for a time silver can be so cheaply mined that profit can be made at 60 cents an ounce; but count all the work done on the veins of the district, county, or State, and it will be found that every ounce of silver obtained has cost from $1.30 to $1.50. It is the same of gold mining. When a man is so fortunate as to hit upon a big deposit of rich ore near the surface, he is often able to take out gold at a cost of from $3 to $5 an ounce, or even less. But these rich pockets in gold veins and the bonanzas in silver veins are few and far between." This pessimistic view of precious-metal mining is based upon the principle of general averages, the prizes being few and the failures many. It does not, however, detract from the success of this kind of mining in those cases which (leaving aside mere strokes of blind luck) rest on known premises and have the advantage of good management. "All gold-bearing veins, great and small, are being examined and prospected, and the placers are being raked over and worked in the best manner possible, most of them being in regions that are almost or quite valueless." The camp mentioned as now the most promising in the State is Silver Star district, in Esmeralda county. Silver Peak, Hawthorne, and Pine Nut are also favorably noticed. "The leading mines of the Comstock are holding out well,"—that is (a point not stated by the author), by depending upon their gold output and treating the silver as a by-product. These mines, popularly supposed to be purely silver producers, have, in the course of their history, turned out over a third of their values in gold, rating the silver at full coinage value ($1.29 per ounce); while of course at present the relative importance of the gold is much greater than formerly.

Proximate Composition of Steel.

IN the *Engineering and Mining Journal* (May 11) Mr. H. M. Howe discusses the results obtained by Prof. Ledebur and published in *Stahl und Eisen*, and incidentally refers to the work of Cheever, Barrows, and Turner. Mr. Howe says: "In order to discover how the different elements are combined with each other in metallic iron, to learn which is combined with which, and according to what formulas,—in short, in order to determine the proximate composition of the metal,—we naturally seek first to remove the great mass of iron itself which separates and dilutes the small quantities of these compounds existing within it, so that we may concentrate and isolate them in a measure, and thus examine them at greater advantage." Of the two most promising ways of doing this, (1) by dissolving the iron away with solvents so weak that they do not affect the compounds initially present, and (2) volatilizing the iron in a stream of chlorine, he says that here, as in so many other cases, methods full of promise and apparently simple on examination are found full of pitfalls, and that we must be sure that the very act of removing the iron does not change the constitution of the compounds which we seek to study. Mr. Howe, examining the chlorine method, points out the inherent difficulties, particularly the oxidation of phosphids to phosphates, etc., the oxygen being derived from entangled iron oxid and perhaps from sand. While Ledebur's results establish little firmly, they should be welcomed, Mr. Howe thinks, both as a

warning of the difficulties involved, and to incite other analysts to devise and follow new methods of studying this very important question.

A Bromo-Cyanid Process.

A PROCESS for the extraction of gold from ores, tailings, slimes, and concentrates, which is proposed by Dr. C. A. Mulholland, of Bathurst, N. S. W., is described by the inventor in the *Australian Mining Standard*. The method is untrammeled by patent rights. It has not yet passed the experimental stage, though satisfactory tests are reported. It differs from the Sulman-Vautin process in that free bromine is used, in connection with potassium cyanid, and not a cyanogen-bromid. The process is based upon the ability of bromine to displace cyanogen from its compounds in the presence of a metal,—to form a double cyanid of the metal and a bromate. The object of adding bromine to the cyanid solution is to liberate cyanogen in a nascent condition, in which state the author claims that it is a much more effective solvent for gold. If an excess of bromine is added, it is stated that potassium bromid and hydrocyanic acid are formed; but that loss of the acid may be prevented by adding alkali. The claim is made that the new process will economize the quantity of cyanid; that the action of the solvent is very rapid; and that the percentage of gold recovered is higher. As to the last point, a saving of 97 per cent. of the gold in slimes is reported; but laboratory tests of this kind are always very unreliable. Another claim is that the bromine may be recovered, after precipitation of gold by zinc (as in the ordinary process), by concentrating the solution by evaporation and treating with hydrochloric acid. This of course would be impracticable on the working scale. It is proposed to use the bromine either (1) by successive small additions while the ore is kept agitated; (2) allowing the cyanid solution to percolate in the presence of bromine vapor; or (3) by blowing air and bromine in suitable proportions through the ore in the leaching solution.

New Mexico's Gold Camps.

A GOLD-MINING region which is attracting considerable attention at present comprises three camps (La Belle, Anchor, and Midnight) in the Sangre de Cristo range, in Taos county, N. M. A correspondent of the Denver *Mining Review* furnishes an account of the history and existing condition of these gold fields, which, though considered new, were known so far back as the '60s, but not systematically prospected until 1893. La Belle is on the Costilla grant, owned chiefly by Dutch capitalists, and the land company has inaugurated a new system of establishing titles to mining ground by deeding the claims after the usual location, filing of notice, and staking, and compliance with the forms of the United States mining laws, the business being transacted direct with the land company instead of through the usual official channels,—the total expense per claim being about $156.

The whole mineral belt is about 20 miles in extent. The surface ores are oxidized, tending to run into sulphurets in depth, but so far are free-milling. The development work consists of numerous small tunnels and short shafts, showing, besides the oxidized ores, black iron ore carrying free gold and also traces of tellurids. There is an abundance of water and timber. La Belle is at an altitude of 9200 ft. above sea-level. A branch railroad is projected to reach the district from the U. P., D. & G. road. A number of mines and prospects are described by the correspondent, who reports rich specimens, but the general average of the ores does not appear to be very high, after making the usual deductions from what is claimed by the owners.

Utilization of Blast-Furnace Cinder.

IN the *Iron Age* Mr. S. Norton, who has made this subject a study for a number of years and has largely experimented in this direction, expresses the opinion that, at least for furnaces making foundry pig, the cinder can be made a source of profit. The question of making use of what has always been a loss, he says, is well worth

the attention of managers "who expect to stay in the business." Summarizing the results so far obtained, he names first among the valuable by-products the so-called "mineral wool" or "slag wool." This has already a large market, and at the present prices the cinder sold as mineral wool would amount, according to Mr. Norton, to more than the sales of pig iron made during the same time. All that is necessary is a reverberatory so built that the molten cinder, as it comes from the blast furnace in the ladle car, can be dumped into the reverberatory; and with a small fire and the admixture of clay or sand it can be brought to the proper state and blown. The wool is used, like asbestos, as a covering for steam-pipes and boilers, for a wall filling for ice-houses, etc. Granulated in water, the cinder makes a sort of hydraulic cement. The wool, ground with a small proportion of slaked lime, becomes a plaster, like alabastine and similar compounds. The cinder can also be run into bricks, either solid or hollow. Past failures to make a good paving-brick, Mr. Norton says, were due to guess-work methods, and he explains how a solid, glasslike brick can be made. The large dumps of old cinder could be utilized for road-making, and, if ground, could be used in place of lime fertilizers on clayey lands.

The Largest Gold Nuggets.

IT is a peculiarity of American gold mines that large nuggets are extremely rare; in fact, the greatest mines seldom show any gold whatever visible to the eye. Very valuable pockets containing large quantities of small gold have been often met with, both in placers and quartz mines; but solid nuggets of good size are infrequent. The great nuggets come from Australia—and not always or usually from the most important mines. A correspondent of the *Mining and Scientific Press* furnishes an interesting list of the famous Australian nuggets, as recorded in the colonial government reports. The largest piece of gold ever found in the world was taken from the Byer & Haltman claim, Hill End, New South Wales, May 10, 1872, its weight being 640 lbs.; height, 4 ft. 9 in.; width, 3 ft. 2 in.; average thickness, 4 in.; value, $148,800. Next on the list come the Oates & Delson, $50,000; Welcome Stranger, $45 000; Welcome, $44,366; Leg of Mutton, $32,380. Following these are several valued at from $10,000 to $30,000. The California list contains one nugget from Carson Hill, Calaveras county, worth $42,000. Several large masses of quartz and gold from California are on record (which, however, are not true nuggets). Among them are one lump from Downieville, Siena county, worth nearly $90,000, and one from the Bonanza mine, Tuolumne county, yielding over $40,000. The writer of this notice has seen the contents of one pocket in a Colorado mine, consisting of large lumps of quartz, clay, and gold, worth altogether about $60,000, taken from a claim which on the whole was not extraordinarily productive.

Tinplate of South Wales.

A VIVID picture of the present depressed condition of the Welsh tinplate industry is presented by Mr. A. Howells, United States consul at Cardiff, an abstract of whose report appears in the *Bulletin* of the American Iron and Steel Association (May 10). Until recently South Wales enjoyed a monopoly of the tinplate trade, and the United States have always been, and still remain, the greatest customer. Since the establishment of American tinplate works, there has been a considerable falling-off in the American demand without any compensating call from other markets. The difference has been an entire loss to the Welsh manufacturers, few of whom appear to be interested in the new works on American soil. The year 1894 is described as "a wretched one," and the present outlook is by no means hopeful. As to the effect of the reduced tariff of the Wilson bill, the consul quotes from an English paper the statement that "the American works, which, it was thought, would have to stop, are going on as vigorously as ever. . . . Their position has actually improved recently, inasmuch as they have obtained a reduction in wages of about 30 per cent., while in Wales the strong effort

made in the same direction has up to the present proved futile, excepting in a few isolated cases." To show the serious decline in tinplate exports the following figures are given:

	1892.	1893.	1894.
To the United States,	£3,702,442	£3,352,693	£2,781,027
Total exports,	£5,330,216	£4,691,300	£4,350,217

THE *Ironworkers' Journal* reports that the result of the accountants' examination of the returns of the sales of manufactured iron, by the firms associated with the board of conciliation and arbitration for the manufactured iron and steel trade of the North of England, shows a net selling price of £4 14s. 10.66d. per ton average, with the result that there is no change in the wages of the men under the sliding scale agreement. The wages, therefore, for June and July will be the same as for April and May. The weight invoiced, upon which the returns were based, amounted to nearly 18,000 tons. The journal compliments Sir David Dale, the referee of the board, upon his well-earned honor of a baronetcy, just conferred upon him in recognition of his services. In reality this is the first time that an honor has been conferred for purely industrial work and in recognition of services in connection with arbitration in labor disputes.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Mining and Metallurgy in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

Metallurgy.

31636. Ledebur on the Proximate Constitution of Steel. Henry M. Howe (Eng & Min Jour–May 11.) 10000 w.

*31699. The Elimination of Impurities During the Process of Making "Best Selected" Copper. Allan Gibb (*Ind & Ir*–May 3.) 2000 w.

*31740. Third Report to the Alloys Research Committee. W. C. Roberts-Austen (*Ir & Coal Tr Rev*–May 3.) 5000 w.

*31743. Recent Improvements in American Metallurgy. Mr. Douglas' Second Lecture (*Min Jour*–May 4) 3300 w.

31747. The Tin Plate Trade of South Wales. Anthony Howells (Bul Ir & St As–May 10.) 1000 w.

31748. I. The Latest Carnegie Armor Plate Test. II. Last Test of Bethlehem Armor Plate (Bul Ir & St As–May 10.) 1200 w.

*31753. The Art of Casting Bronze in Japan. Ill. W. Gowland, with Discussion (*Jour Soc of Arts*–May 3.) 20000 w.

†31774. The Volumetric Determination of Zinc and a New Indicator for Ferrocyanide. George C. Stone (Jour Am Chem Soc–June.) 1300 w.

*31784. The Golden Bar Milling Plant, Coolgardie (W. A.). W. A. Robertson, in the Goldfield's Courier (*Aust Min Stand*–March 23.) 1100 w.

*31792. A Bromo Cyanide Process.—Improved Method of Treating Auriferous Ores, etc. C. A. Mulholland (*Aust Min Stand*–April 13.) 1000 w.

31840. How to Get Smooth Castings. W. Hales (Ir Tr Rev–May 16.) 600 w.

31849. Cyaniding or Chlorination? E. A. Schneider (Eng & Min Jour–May 18) 800 w.

3 1864. The Reduction of the Rarer Metals from Their Oxides. W. C. Roberts Austen, with Discussion (*Jour Soc of Arts*–May 10.) 4000 w.

*31895. Metal Mixers. Arthur Cooper, with Discussion (*Ir & Coal Tr Rev*–May 10. 3800 w.

*31907. Recent Improvements in American Metallurgy. Mr. Douglas' Third Lecture (*Min Jour*–May 11.) 3200 w.

*31919. The Effect of Arsenic on Steel. John Edward Stead (*Ir & St Tr Jour*–May 11.) 8000 w.

31939. Some Mechanical and Electrical Features of the Carnegie Steel Company's Building, Pittsburg, Pa. Ill. Henry Floy (Elec Eng–May 22.) 2800 w

31964. Ramming. Ill. H. Hansen (Foundry–May.) 2800 w.

*31966. Ternary Alloys of Iron with Chromium, Molybdenum, and Tungsten. James S. De Benneville (*Ironmonger*–May 11.) 11900 w.

31991. The Golden Bar Dry-Crushing and Cyanide Plant, Coolgardie (Eng & Min Jour–May 25.) 900 w.

31994. Structural Adjustments for Expansion and Contraction. Editorial (Eng Rec–May 25.) 1000 w.

*32008. Effects of Temperature on the Strength of Wrought Iron. Editorial (*Engng*–May 17.) 1500 w.

*32013. Recent Improvements in American Metallurgy. Fourth and Last Lecture of James Douglas (*Min Jour*–May 18.) 2500 w.

*32021. A Twenty-five Years' Retrospect of the Iron and Steel Industries. Ill. (*Ir & Coal Tr Rev*–May 17.) 4500 w.

*32024. Modern Methods of Chemical Analysis of Iron and Steel. Anon. (*Ir & Coal Tr Rev*–May 17.) 3300 w.

*32025. Desulphurizing in the Basic Open Hearth. E. H. Saniter (*Ir & Coal Tr Rev*–May 17.) 900 w.

†32049. Crystallization or Fatigue. F. E. R. (*Ind Eng*-April 27.) 2500 w.

32126. The Manufacture of Face Hardened Armor. Extract from paper by A. A. Ackerman (Ir Age-May 30.) 3600 w.

32138. Tin-Plate Manufacture in Austria (Am Mfr & Ir Wld-May 31.) 2000 w.

*32172. The Dressing and Metallurgical Treatment of Nickel Ores. Ill. A. G. Charleton (*Jour Soc Arts*-May 24.) 30000 w.

*32176. The Treatment of Pyritous Concentrates by Cyanide. A. F. Crosse (*Min Jour*-May 25.) 1500 w.

*32178. Determining Chromium in Chrome Ores. Edmund Clark (*Chem Tr Jour*-May 25.) 1200 w.

32187. The Elimination of Impurities During the Process of Making "Best Selected" Copper. E. D. Peters, Jr. (Eng & Min Jour-June 1.) 1800 w.

*32197. A New Form of Calcining Kiln for Ironstone. (Abstract.) Charles Wood (*Col Guard*-May 24.) 2500 w.

*32387. Castings and Patterns (*Mech Wld*-May 31.) 1100 w.

Mining.

31637. The White Cliffs Opal Fields, New South Wales. F. G. de V. Gipps (Eng & Min Jour-May 11.) 1500 w.

31638. The Mining Industry of Bolivia (Eng & Min Jour-May 11.) 2000 w.

*31654. Coal Washing Plant, Powell Duffryn Company's Elliott Pits. Ill. (*Eng*-May 3.) 1000 w.

*31657. Alteration of Coal Due to Subsidence at the Montrombert Colliery, Loire, France. Ill. (*Col Guard*-May 3.) 1000 w.

*31658. The Coal Mines Regulation Bill, 1895.—Report of Thomas Ratcliffe Ellis (*Col Guard*-May 3.) 9400 w.

31696. New Mexico's Great Gold Camp. Ill. Dean Burgess (Min Rev-May 10.) 2300 w.

*31742. The Road to Coolgardie. Brenton Symons (*Min Jour*-May 4.) 1800 w.

*31745. Mining Captains. Editorial (*Min Jour*-May 4.) 1200 w.

*31785. The Kapanza Mine, Coromandel (N. Z.)—Deep Level Work (*Aust Min Stand*-March 23.) 1000 w.

*31786. Underground Haulage. A. Gardiner (*Aust Min Stand*-March 30.) 2300 w.

*31789. The "Indicator" Feature in Some Gold Occurrences. William Bradford (*Aust Min Stand*-April 6.) 2300 w.

31822. The Mines of Nevada. Dan de Quille (Min & Sci Pr-May 11.) 800 w.

31848. Coal Mining in the Transvaal, South Africa (Eng & Min Jour-May 18.) 800 w.

*31867. Observations on the Coal Mines Regulation Bill, 1895. Thomas Ratcliffe Ellis (*Col Guard*-May 10.) 9000 w.

*31876. Marble and Granite in Georgia. Ill. (Stone-May.) 8500 w.

31883. Electricity or Compressed Air in Mining. J. H. Piper (Tradesman-May 15.) 6400 w.

*31910. Coolgardie. Brenton Symons (*Min Jour*-May 11.) 3200 w.

*31965. The Mines of Elba. Herbert Scott (*Ironmonger*-May 11.) 7500 w.

31977. The Oro Blanca Country. Don C. Pickett (Min & Sci Pr-May 18.) 1000 w.

31990. Mexican Taxes on Gold and Silver, with Editorial (Eng & Min Jour-May 25.) 1500 w.

*31998. The Coal Fields of Northern Europe (*Bd of Tr Jour*-May.) 900 w.

*32012. The Londonderry Mine. Brenton Symons (*Min Jour*-May 18.) 1300 w.

†3 092. The Sinking of the Ladd Shafts. Ill. George S Rice (School of Mines Quar-April.) 5000 w.

32112. The Gold Belt of Calfornia. H. W. Turner (Sci Am Sup-June 1.) 3500 w.

33185. Metalliferous Mining in New Zealand. John Plummer (Eng & Min Jour-June 1.) 700 w.

32186. Electric Haulage at the Berwind-White Company's Eureka No. 22 Colliery. Timothy W. Sprague (Eng & Min Jour-June 1.) 2000 w.

*32195. New Regulations as to Mine Explosives in Germany (*Col Guard*-May 24.) 2200 w.

*32196. Structure of the Belgian Coalfield. F. Cambessedès (*Col Guard*-May 24.) 3300 w.

*32199. Half-a-Century of French Coal Production and Consumption (*Col Guard*-May 24.) 1100 w.

*32203. Rateau Fans at the Lens Colliery. Ill. (*Eng*-May 24.) 2000 w.

*32243. The Russian Petroleum Industry (*Fairplay*-May 24.) 1100 w.

32298. The Mining Industry of Bolivia. From Report of British Consul (Sci Am Sup-June 8.) 1800 w.

32300. Further Notes on the Gold Ores of California. H. W. Turner (Min & Sci Pr-June 1.) 2200 w.

32333. Gunpowder and Nitroglycerine. W. Hodgson Ellis (Can Min Rev-May.) 1400 w.

*32355. Blown-Out Shots. James Ashworth (*Col Guard*-May 31.) 1700 w.

*32356. Safety in Mining. (Abstract.) W. N. Atkinson (*Col Guard*-May 31.) 3400 w.

*32357. Report of Her Majesty's Inspectors of Explosives (*Col Guard*-May 31.) 7500 w.

*32358. Use of Electricity in Mines. Ill. Translated from La Revue Technique (*Col Guard*-May 31.) 3300 w.

*32367. Mine Gases.—Their Analyses by Absorption, by Means of the Hempel Apparatus. Baird Halberstadt (Col Eng-June.) 2000 w.

*32368. Sulphur Mining.—A Description of the Sulphur Mine at Davis, Mass. E. McCormick (Col Eng-June.) 1200 w.

*32392. Certain Dissimilar Occurrences of Gold-Bearing Quartz. Ill. T. A. Rickard, with Discussion (*Min Jour*-June 1.) 6000 w.

Miscellany.

31847. The "Flouring" and "Sickening" of Mercury. T. A. Rickard (Eng & Min Jour-May 18.) 1100 w.

*31868. Unloading British Coal at a Foreign Port, with Tables of Comparative Heat Values. M. J. Buser (*Col Guard*-May 10.) 1400 w.

*31878. Compressed Air Power as Applied to Quarry Work. From Catalogue of the Ingersoll-Sergeant Drill Co. (Stone-May.) 4000 w.

*31894. Presidential Address of Mr. David Dale (*Ir & Coal Tr Rev*-May 10.) 9500 w.

*32022. The Iron Trade Situation at Home and Abroad. Anon. (*Ir & Coal Tr Rev*-May 17.) 2000 w.

*32177. The Electric Lighting of Mines. Editorial (*Min Jour*-May 25.) 1800 w.

32180. Coal Washing—Notes on Its Progress in the South (Tradesman-June 1.) 2000 w.

32183. Manufacture of Cement from Blast-Furnace Slag. Editorial on Article by Hermann Crueger (Eng & Min Jour-June 1.) 900 w.

32184. Mineral and Metal Production of the United States in 1893 and 1894 (Eng & Min Jour-June 1.) 1400 w.

*32194. The Mint—Past and Present. Joseph Newton (*Ill Car & Build*-May 24.) 2300 w.

*32198. Continental Competition in the Iron and Steel Industries. Extracts from report of William Jacks and J. S. Jeans (*Col Guard*-May 24.) 3800 w.

*32232. The Rise of the Scotch Steel Industry (*Ir and Coal Tr Rev*-May 24.) 3500 w.

*32237. Algerian Alabaster (*Arch*-May 24.) 1800 w.

*32369. Riedler Pumps and Air Compressors. (Col Eng-June.) 1300 w.

Serials.

20413. Mining Methods. Ill. (Col Eng-Began March, 1894—16 parts to date—30 cts. each).

20414. Geology of Coal. Ill. (Col Eng-Began March, 1894—16 parts to date—30 cts. each).

20415. Mining Machinery. Ill. (Col Eng-Began March, 1894—16 parts to date—30 cts. each).

20416. Chemistry of Mining. Ill. (Col Eng-Began March, 1894—16 parts to date—30 cts. each).

22710. Science for Ironmongers. By a Member of the Royal Institution (*Ironmonger*-Began June 2, 1894—19 parts to date—30 cts. each).

27329. Coal-Mining Economy Up to Date (*Ir & Coal Tr Rev*-Began Nov. 23, 1894—14 parts to date—30 cts. each).

29468. The Cyanide Process—Its Practical Application and Economical Results. A. Scheidel (*Min Jour*-Began Feb. 9—Ended May 18—14 parts—30 cts. each).

30047. Prospecting—Where and How to Find Gold and Silver Deposits. Ill. Arthur Lakes (Col Eng-Began March—4 parts to date—30 cts. each).

30049 Mine Surveying—Latest American Ideas and Most Improved Practice. Edward B. Durham (Col Eng-Began March—4 parts to date—30 cts. each.

30214. Coke Making. Ill. William Bowron (Tradesman-Began March 15—4 parts to date—15 cts. each).

30461. The History of Iron. Notes from Dr. Ludwig Beck (Ir Age-Began March 28—6 parts to date—15 cts. each).

30912. The Glasgow Iron and Steel Company's Works, Wishaw. Ill. (*Engng*-Began April 5—3 parts to date—30 cts. each).

31330. Colliery Surface Works. Edward Brownsfield Wain (*Col Guard*-Began April 19—Ended May 10—4 parts—30 cts. each).

31459. Is the Use of Cyanide of Potassium for Gold Extraction Common Property? E. Andreoli (Eng & Min Jour-Began May 4—2 parts to date—15 cts. each).

31504. Modern Foundry Practice. Ill. (*Engng*-Began April 26—2 parts to date—30 cts. each).

31511. The Tin-Plate Industry in the United States (*Eng*-Began April 26—Ended May 31—5 parts—30 cts. each).

31709. The Rarer Metals and Their Alloys. Ill. W. C. Roberts-Austen (*Nature*-Began May 2—2 parts to date—30 cts. each).

31744. Mining and Milling at the Mesquital del Oro Gold Mine, State of Zacatecas, Mexico. Arthur C. Claudet (*Min Jour*-Began May 4—1 part to date—30 cts).

31783. Tin-Mining in Northern Queensland. John Munday (*Aust Min Stand*-Began March 23—Ended March 30—2 parts—30 cts. each).

31788. Chromite Mining in the Gundagai and Tumut Districts (N. S. W.) Joseph E. Crane (*Aust Min Stand*-Began March 30—Ended April 6—2 parts—30 cts. each).

31790. Hydraulic Gold-Sluicing on the West Coast of Tasmania (*Aust Min Stand*-Began April 6—2 parts to date—30 cts. each).

31793. The Commercial Use of Minerals. Norman Danvers Power (*Aust Min Stand*-Began April 13—1 part to date—30 cts).

31908. Victorian Gold Mining. Thomas Cornish (*Min Jour*-Began May 11—4 parts to date—30 cts. each).

31909. Deep Level Mining on the Rand. Editorial (*Min Jour*-Began May 11—Ended May 18—2 parts—30 cts. each).

32020. Cyanide Practice.—Report of paper by Alfred James (*Eng*-Began May 17—Ended May 24—2 parts—30 cts. each).

32027. Early Recollections of the Iron Trade. Anon. (*Ir & Coal Tr Rev*-Began May 17—1 part to date—30 cts).

We supply copies of these articles. See introductory.

MUNICIPAL ENGINEERING

Rapid-Transit Problems.

THE relation of the adopted rapid-transit lines to the other means of communication in New York city is the subject of a letter by Mr. Fr. von Emperger, addressed to *Engineering Record*, which, together with two small diagrams, occupied five columns of the issue of that paper for May 11. There is much in this letter to merit consideration from New Yorkers, and to call out the editorial comments bestowed upon it in the same issue; and there are points also made that are worth considering in all large cities contemplating the construction of rapid-transit roads. The points of merely local interest here in New York we shall not review, confining our notice to what is of more general import, both in the letter and in the editorial called out by it. In our opinion the most noteworthy point is the stress laid upon the wisdom of making haste slowly in developing any engineering scheme of such weighty influence upon the future welfare of a city as a system (properly so-called) of rapid communication between all its principal parts, and over the principal directions in which the daily tide of population ebbs and flows. A mistake at the outset may adversely affect the growth and prosperity of a city for all time.

Mr. Emperger calls attention to the fact that all the large cities, both here and in Europe, have had to grapple with the question of rapid transit. Though many of the problems connected with it are local for any particular city, there are some that are general in their application. Thus the author regards "the slow progress made by the New York Rapid Transit Commission," as the least thing to blame them for, "because any final decision they have yet arrived at has such far-reaching consequences to the whole life of the city for generations" that "he prefers to call them slow" rather than "to see them do some irreparable damage." We must "get rid of the narrow-minded idea that we have only to provide for the present need, and get up to some far-looking point of view."

"It is clear that the value of a line from an investor's point of view and from that of the public cannot be the same, because for the one a certain expense in the construction requires a corresponding number of passengers, while for the public a line keeps its value, and the cost of construction may be high or low. It may be in the public interest to build a road only for the benefit of certain surroundings. . . . Even enterprising private capitalists have done this, but there was then backing up by the real-estate interest, or by the government. The latter way is usual in Europe. It does not mean, as is often heard these days, 'that the city pays $50,000,000.' It only means that the government has investigated the question, and found it safe for private investment, and in doing so it backs up its opinion by saying: 'In case we are wrong, we will pay the interest.'"

"The routes adopted for rapid transit should be main communications and connect with all the present routes." These routes "should be considered as main arteries, of which the other companies are the feeders."

The plans adopted by the New York commission are elaborately criticised with reference to existing local roads. This criticism is, however, pervaded throughout with a spirit of fairness. The opinion that "it is faulty engineering to propose engineering structures without considering all their details in advance," and that "the purposes for which they are built should receive the most careful attention," is one that applies to all municipal work, and, in fact, broadly in all departments of engineering. The opinion that "neither a good plan nor the desirable improvements of traffic can be obtained without municipal control" is expressed; but the author does not favor municipal ownership in this country.

Editorially, *Engineering Record* depre-

cates, the "importance" given by "portions of the public press" . . . . to the apparently slow progress made by the New York Rapid Transit Commission, and thinks such impatience will not be shared by engineers, who, "at least, will appreciate the gravity of the problem and the difficulties which attend its solution." A wholesome doubt as to the advisability of intrusting American municipalities with the expenditure of large sums in such enterprises is indicated in the closing paragraph of the editorial.

"There is a great deal to be said on both sides of the question of involving the credit of the city of New York to a greater extent than $50,000,000, and we do not propose to enter upon any attempt to show whether it would be wise or unwise to do so. It is perhaps Utopian to look forward to the time when the city government could be trusted to enter upon an expenditure so great for the benefit of all its citizens; and yet, until that time comes, no municipal government will have attained to a condition in which either efficiency or economy can play its full part. Although past experience with the New York city government may be taken to demonstrate the unwisdom of such a procedure as entrusting to it the expenditure of so great a sum as that just named in connection with rapid-transit lines, it is doubtless true that that amount of money judiciously and honestly expended for genuine rapid-transit facilities in New York city would be one of the best possible investments for its present and ultimate benefit that could possibly be devised. In such a case, however, it would not necessarily follow that some part of such an expenditure should not be applied to the perfecting of present facilities."

Interference of Frost in Gas Manufacture.

A PAPER read by Mr. William Hardie before the North of England Gas Managers' Association (*The Gas World*, May 4) portrays some of the difficulties experienced from frost by English gas-works during the past winter. These difficulties culminated in the early part of February, at which time the frost was more severe and continuous than at any previous time for 30 years, and the damage done to gas- and water-mains is stated to be entirely without precedent.

An important point made in this paper is that much of the inconvenience experienced with scrubbers and washers may probably be avoided "by laying off a portion of the condensers so as not to cool the gas excessively." This plan was pursued at Tynemouth with very satisfactory results, the gas inducted to the scrubbers never being at a temperature below 60° F. The steam and water pipes at these works are wrapped with straw rope, and encased in boxes filled with sawdust. The purifiers are "fitted with hydraulic valves, and are supplied from tanks at one end of the house, through 3-in. and 4-in. pipes. The water in the leading supply-pipes was kept circulating by running a small quantity off at the end farthest from the supply-tanks," and a little steam was allowed to flow into the water near the tanks. A little steam was also allowed to flow into the purifier lutes, as occasion seemed to demand.

A curious experience with a purifier during the frost period is recounted. "This purifier had been filled with lime that had been prepared 2 or 3 days previously, and was not put to work for about 48 hours after being filled, when it was found that the gas would not pass through it. Means were taken to make sure that the valves and pipes were quite clear, after which it was decided that the severe frost acting on the moisture in the lime had caked it into a more or less solid mass. The gas was then forced through at a high-pressure,—the difference between the inlet and outlet of the purifier being about 12 in. water pressure,—and steam from a ¾-in. pipe was allowed to play upon the inlet pipe. The heat caused by the steam and by the chemical action of the impurities of the gas upon the lime caused it gradually to come to its normal condition; and in about 3 hours the gas was passing through with a difference in pressure of about 1 in."

Temporary steam-pipes were also used for keeping the water from freezing in the gas-holders. As indicating the severity of

the frost, an instance of the freezing of the water in one gas-holder is cited, requiring the use of coke fires for thawing it out. It is recommended to use a portable boiler in gas-works, not only to keep the gas-holders right in frosty weather, but for many other purposes in and around gas-works. It was, however, in the distributing systems that the gas manufacturers experienced the greatest embarrassment. Broken mains and stoppages occurred nearly everywhere. There were ten times as many complaints from consumers as were received in the previous year. The stoppages were not entirely due to frozen water, but partly to deposits of hydrocarbons of the benzine and naphthalene series that occur at the freezing temperature of water. If, however, water vapor be not present in the gas, these latter deposits do not occur, and no stoppage either by ice or hydrocarbons can occur.

"The usual methods adopted to remove these obstructions is to pour salt and boiling water down the service, and then use the air force-pump to drive it into the main pipe. With the lamp services we generally use a steel wire down the pipes before employing the force-pump. Occasionally, using the force-pump blocks the service so hard that it can only be cleared by lifting the ground; but this is, forfunately, a rare occurrence. We have also used a non-freezing composition for removing the lamp stoppages, which our workmen consider assists them very much."

In the discussion elicited by this paper it was brought out that steam-engines have been largely superseded by gas-engines in gas-works, which emphasizes the importance of keeping a portable boiler at hand for ready use, as suggested by Mr. Hardie. In response to a request for an explanation of the reason why gas-mains break in frosty weather, Mr. Hardie said he thought they "were really broken by the frost, and that probably the reason was that the ground was so hard bound that the contraction which took place could not get free vent, as it would under ordinary circumstances when the ground was more pliable." He thought there was no doubt that during a severe frost pipes were broken. With regard to the temperature of the gas, he thought it was bad practice to reduce it to a lower point than he had mentioned,—about 60° F. There was no doubt that at many places people had suffered very much in the washers and scrubbers, and had had them thrown out of action for some very considerable time. He could not conceive that this could occur otherwise than by having gas going into them at too low a temperature.

Sewer Outlets in Sliding Banks.

THE banks of Lake Erie at Cleveland are bluffs 50 to 70 ft. above the shore line. The drainage of the city issues from the mouths of the sewers at the shore line, and, to prevent the frequent sliding of the banks from interfering with the maintenance of the sewer outlets, a kind of construction differing from that usually employed has been necessitated. This construction is described in *The Engineering Record* (May 18) with illustrations, showing the geological character of the banks and the method employed for repairing sewers broken by these slides, one of which broke off 150 ft. of the sewer, threatening the undermining of adjacent buildings.

"The top of the bluff to a depth of 10 to 14 ft. is a bed of sand and gravel, underlaid by a stratum of sand and clay, which rests in turn on a deposit of blue marly clay. The last is described as principally fine sand, and nearly enough clay to cement it, and a sufficient quantity of lime to give it a marly character. In a wet state the material has somewhat the character of quicksand, although compact sand and hard when dry. Before protective measures were adopted, there had been a general encroachment of the lake at Cleveland amounting to 205 ft. in a period of 46 years. In some instances the slides have caused piling 50 to 75 ft. from the shore to rise up several feet with the upward heave of the bottom, the latest slide crowding the older ones before it."

"The conditions favorable to a landslide are as follows: First, as this clay has very little tenacity in a dry state, the foot of the slope is rapidly dissolved and washed away by the waves at such times.

Second, the material cracks under the summer heat, and during wet weather the sand and gravel layer overlaying the sand becomes saturated with water, which seeps out in many springs along the face of the bank, follows the crevasses, and assists to lubricate the unstable mass. Therefore any permanent work of construction on such a bank must contemplate the cutting-off and diversion of the surface water by drains reaching down to the clay, and also the protection of the foot of the bank by jetties or otherwise. The old method of construction has been to carry brick construction close to the water's edge, where a massive stone outlet was built, no effort being made to preserve the bank. The consequence of a slide was usually a sheared sewer and a washout."

The plans adopted for repairs of existing outlets, and for the prevention of their injury by sliding of the banks, "provided for a riveted steel sewer 5 ft. in diameter supported on 35-ft. white-oak piles 12 in. in middle diameter and 8½ ft. apart. Crosspieces were gained into the piles to support the pipe, and waling strips were bolted on them at the top to give additional strength. The greatest difficulty was experienced in taking care of the water and in making a good joint between the steel pipe and the brick sewer. The former was laid from the lake inland, until there was a gap of about 5 ft. between it and the brickwork. After the joints were calked with lead, and the pipe thoroughly inspected, a specially-designed connecting piece was dropped into place, and a concrete foundation was built up around the joint for about 4 ft. on each side. The pipe was constructed of ⅜-in. tank steel in 30-ft. lengths and dipped in a bath of California asphalt after being previously heated to a temperature of 300° F. About 1½ ft. of clay puddle was packed around the pipe carefully for its entire length, so as to protect it from any water which might seep through the refilling, largely composed of cinders from the plant of the United States Salt Company. A 6-in. drain tile was run along the bank near the main sewer to cut off the ground water as far as possible. The trench was then refilled for a depth of 4ft. with sand and gravel properly tamped." The grade of the sewer is uniform,—64 per cent. The steel pipe is made of two sections each 30 ft. long, one of 25-ft. and one of 5 ft., and it connects with a box 60 ft. in length. This box is sustained by piles with 10″ × 10″ cross-caps 9 ft. long. The junction of the pipe with the box is a flange, riveted to a plate which is bolted to the sides and bottom of the box. The cost of repairs is stated to have been about $5500.

Gas Enrichment.

IN his address before the North of England Gas Managers' Association at its April meeting (*Journal of Gas Lighting*, April 30), the president, Col. Sadler, spoke of gas enrichment as the absorbing question of the hour in the gas industry. "The continuous cry from gas consumers for more light, and the never-ceasing efforts of gas-makers to produce still cheaper gas, compel the latter to tax every resource within their power to accomplish these widely-divergent ends,—*viz.*, higher illuminating power without seriously increasing the cost. Cheaper coal, and less gas taken off, will do it, of course. But the first is not always available, and the second not often convenient. A larger yield of gas per ton of coal and the enrichment of its low illuminating power naturally suggests itself to everyone as the readiest solution of the problem."

Neither oil or carburetted water-gas will ever seriously come into competition with coal-gas where there is an exhaustible supply of good gas coal. The sudden and unexpected advance in the prices of mineral oils places carburetted water or oil-gas out of the running at the present. The long period of unprofitable returns in the oil trade makes it improbable that there will be an early return to the low prices lately prevailing.

The incandescent burner has gone so far in "settling the question of more light independently of the candle-power" that the speaker thought nothing more would need to be said about the matter, had it not also been discovered that a rich gas is both better and more economical with

the mantle burner. "Good gas will be wanted, notwithstanding the general adoption of the incandescent light; and benzol is the best and cheapest, as well as the most natural, enricher of coal-gas. It requires some courage to say this after the brilliant and classic researches of Professor Lewes on acetylene, which shot athwart the sky of the gas world like a dazzling meteor, paling for the time all our poor attempts at illumination."

"I have been asked to say a few words about acetylene. Well, it is a malodorous gas, which all here will have often observed when ordinary gas is burned with insufficient air, as happens when a Bunsen burner is lit at the bottom, or has lit-back, as is often the case with cookers and gas-stoves. It is a very posionous gas; and, owing to its ready tendency to polymerize, —*i. e.*, form molecules of hydrocarbons, either multiples of itself or (by deposition of carbon and other rearrangements of its atoms) hydrocarbons of more complex structure,—it explodes with the slightest detonation."

THE TECHNICAL INDEX—1895.

Current Leading Articles on Municipal Engineering in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

Gas Supply.

*31680. The Frost and the Gas. W. Hardie, Jr. (*Gas Wld*-May 4.) 2500 w.

31697. A Graphic Discourse on Some of the Compounds of Illuminating Gas. A. W. Wilkinson (Am Gas Lgt Jour-May 13.) 1700 w.

*31706. The Determination of Sulphuretted Hydrogen and Other Impurities in Coal Gas. J. T. Sheard (*Jour Gas Lgt*-April 30.) 900 w.

*31707. On a Property of the Non-Luminous Atmospheric Gas Flame.—Report of paper by Lewis T. Wright (*Jour Gas Lgt*-April 30.) 1700 w.

*31708. Notes on Gas Enrichment.—Presidential Address of Col. Sadler, with Discussion (*Jour Gas Lgt*-April 30.) 6000 w.

31768. Upon the Determination of Tar in Gases. Ill. W. Leybold (Pro Age-May 15.) 1800 w.

*31796. Inaugural Address of F. G. Dexter (*Jour Gas Lgt*-May 7.) 7200 w.

31845. Means of Using Incandescent Gas Lamps Out of Doors. Ill. (Am Mfr & Ir Wld-May 17.) 600 w.

*31930. The Work of the Photometric Standard Committee. Vivian B. Lewes (*Gas Wld*-May 11.) 6000 w.

*31931. The Modern Gas Engine: Its Development and Application. G. E. Stevenson (*Gas Wld*-May 11.) 5700 w.

*31932. Report of the Standards of Light Committee (*Gas Wld*-May 11.) 1600 w.

*31981. Presidential Address of C. C. Carpenter (*Jour Gas Lgt*-May 14.) 4500 w.

*31982. On the Temperatures Employed in the Distillation of Coal. Lewis T. Wright (*Jour Gas Lgt*-May 14.) 3800 w.

*31983. Dibdin's Ten-Candle Pentane Argand Air-Gas Standard. Ill. (*Jour Gas Lgt*-May 14.) 760 w.

*32044. The Work of the Photometric Standards Committee.—Discussion of paper by Vivian B. Lewes (*Gas Wld*-May 18.) 5000 w.

*32045. The Modern Gas Engine: Its Development and Application. Discussion of paper by G. E. Stevenson (*Gas Wld*-May 18.) 2500 w.

32309. How We Made Acetylene. By One of Them (W Elec-June 8.) 1000 w.

*32046. Acetylene and Its Enrichment Value. Vivian B. Lewes, with Discussion (*Gas Wld*-May 18.) 5400 w.

32067. Incandescent Gas Lighting. S. M. Highlands, with Discussion (Am Gas Lgt Jour-May 27.) 8500 w.

32068. Metal Gasholder Tanks. Allen S. Miller, with Discussion (Am Gas Lgt Jour-May 27.) 3700 w.

32069. Advantage of the Metric System for All Calculations. George H. Harper, with Discussion (Am Gas Lgt Jour-May 27.) 4500 w.

32075. Natural Gas as a Pioneer for Artificial Fuel Gas. Donald McDonald (Am Mfr & Ir Wld-May 24.) 2500 w.

*32129. Discussion on Lewis T. Wright's Paper on "The Temperatures Employed in the Distillation of Coal" (*Jour Gas Lgt*-May 21.) 1600 w.

*32130. Installation of Carburetted Water Gas at Tottenham. A. E. Broadberry, with Discussion (*Jour Gas Lgt*-May 21.) 7500 w.

*32131. Sloping Retorts. J. Husband (*Jour Gas Lgt*-May 21.) 3000 w.

32139. Acetylene. F. L. Slocum (Am Mfr & Ir Wld-May 31.) 2000 w.

32155. Experience with Foul Gas. James T. Linn, with Discussion (Pro Age-June 1.) 3300 w.

32157. Variations in Temperature in the Interior of Gas Holders. W. Leybold (Pro Age-June 1.) 1800 w.

*32236. The Monier System of Cement Construction as Applied to Gas Works. F. D. Marshall, with Discussion (*Gas Wld*-May 25.) 4800 w.

32265. Recuperative Furnaces as Applied to Bench Firing; Their Operation and Results. J. A. Faux, with Discussion (Am Gas Lgt Jour-June 3.) 2500 w.

32266. Ammoniacal Liquor; with a Special

Reference to the Universal Saving of the Same by Gas Companies. George Osius (Am Gas Lgt Jour–June 3.) 3000 w.

*32345. Discussion of J. Husband's Paper on "Sloping Retorts" (*Jour Gas Lgt*–May 28.) 4300 w.

*32346. The Manufacture of Sulphuric Acid by Sulphate of Ammonia Makers. Fletcher W. Stevenson, with Discussion (*Jour Gas Lgt*–May 28.) 5400 w.

*32347. Purified Ammoniacal Liquor and Its Uses in Gas Purification. T. Holgate, with Discussion (*Jour Gas Lgt*–May 28.) 2800 w.

*32349. Gas Works Construction. A. Drage, with Discussion (*Jour Gas Lgt*–May 28.) 6800 w.

Sewerage.

31722. Metropolitan Sewerage Works, Boston, 1894. Ill. (Eng Rec–May 11.) 3500 w.

31841. Sewer Outlets in Sliding Banks, Cleveland, O. Ill. (Eng Rec–May 18.) 800 w.

31995. The Drainage of New Orleans. Ill. (Eng Rec–May 25.) 5000 w.

†32283. Pneumatic System for Small Sewage Works. William Fairley (San–June.) 900 w.

Streets and Pavements.

31830. The International Street Sweeping Machine. Ill. (Eng News–May 16.) 900 w.

31843. Paving Brick, from the Standpoint of the Engineer and Manufacturer. Daniel W. Mead (Eng Rec–May 18.) 3000 w.

*31900. Street Subways for Large Towns. Charles Mason (*Arch*–May 10.) 3600 w.

32109. The Clean Streets of Rome. From the New York Sun (Sci Amer–June 1.) 1200 w.

*32224. America's Vitrified Brick Pavements. Ill. William Pierson Judson (Paving–June.) 2500 w.

*32225. Street Sanitation. W. F. McNutt (Paving–June.) 700 w.

*32227. Kinds of Stone Suitable for Road-Making. Clemens Herschel (Paving–June.) 300 w.

Water Supply.

31634. A Six-Foot Windmill for Domestic Water Supply. Ill. (Met Worker–May 11.) 800 w.

31968. The New Water Supply of Atlanta. Ill. Joel Mable (Eng News–May 23.) 800 w.

31969. New Stand Pipe at St. Bernard, O. Ill. George Hornung (Eng News–May 23.) 1400 w.

31973. Submerged Wooden Water-Works Intake Pipe, New Whatcom, Wash. C. M. Adams (Eng News–May 25.) 800 w.

32065. Pumping Water on the Ohio River (Fire & Water–May 28.) 1000 w.

†32093. The New Conduit of the Rochester Water Works. E. Kuichling (School of Mines Quar–April.) 15500 w.

32136. Should the Building of Stand-Pipes Be Abandoned? Editorial (Eng News–May 30.) 1700 w.

32137. Cost of Pumping Water for Cities, Towns and Villages. (Abstract.) Samuel G. Artingstall (Eng News–May 30.) 900 w.

32163. Gas and Oil Engines for Water Works Service in Germany. Translation of paper by Max Munzel (Eng Rec–June 1.) 3600 w.

32210—$1.25. Digest of the Experiments Made by Mr. Michael Longridge, Chief Engineer of "The Engine, Boiler, and Employers' Liability Insurance Company" of Manchester, England, on the Triple Expansion Pumping Engines at the East London Water Works, Lea Bridge and Described in His Report to the Company for 1893 (Jour Am Soc Nav Eng–May.) 22500 w.

*32348. The London Water Supply in the Past Year. From Report of Dr. Frankland (*Jour Gas Lgt*–May 28.) 2000 w.

Miscellany.

31723. The Relation of the Adopted Rapid Transit Lines to the Other Means of Communication in New York City. Fr. von Emperger, with Editorial (Eng Rec–May 11.) 5700 w.

*31749. Ideal Sanitation. (Extract.) B. W. Richardson (*Brit Arch*–May 3.) 1800 w.

31779.—$1. State Supervision for Cities. J. R. Commons (An Amer Acad–May.) 6000 w.

*31795. An American on British Municipal Government.—Review of Article by M. J. Francis, in The Engineering Magazine, and Work by Albert Shaw (*Jour Gas Lgt*–May 7.) 2000 w.

*32033. The Limits of Municipal Enterprise (*Builder*–May 18.) 1100 w.

*32089. Why Municipal Reform Is a Failure. Charles E. Burton (Am Mag of Civ–June.) 1500 w.

*32226. Municipal Engineering in Troy, N. Y. Ill. (Paving–June.) 3000 w.

32290. Street-trees (Gar & For–June 5.) 1500 w.

Serials.

5358. Sewage Purification in America. Ill. (Eng News–Began July 14, 1892—46 parts to date—15 cts. each).

14839. Water Purification in America. Ill. (Eng News–Began Aug. 3, 1893—17 parts to date—15 cts. each).

27603. A Treatise on the Construction of Railroad Rolling Stock. A Flamanche, A. Huberti, and A. Stevart (R R Car Jour–Began Dec., 1894—5 parts to date—15 cts. each).

30948. The New Rochester Water Works. Ill. (Eng Rec–Began April 13—Ended May 25—6 parts—15 cts. each).

31082. Water Supply and Pipe Distribution. Ill. F. C. Moore (Fire & Water–Began April 20—7 parts to date—15 cts. each).

31480. Sewerage in Foreign Cities. Edward Downes (San–Began May—2 parts to date—45 cts. each).

31701. Fires and Fire Engines in the Olden Times. William Perry (Can Eng–Began May—1 part to date—15 cts).

32223. Sanitary Engineering. William Paul Gerhard (Jour Fr Inst–Began June—1 part to date—45 cts).

We supply copies of these articles. See introductory.

RAILROADING

Western Railroad Construction.

MR. W. B. LAWSON contributed to the *Journal of the Association of Engineering Societies* for April a paper the primary purpose of which, as he declares, "is to place before the reader an outline sketch of the methods used in constructing our western railways, and something of the circumstances surrounding the builders; not to give theoretical instruction, or to tell an unknown tale. The author has been for some 25 years in the midst of the fray, both as a pawn and as a player in the game, and the statements made are such as his experience warrants.

"The lenses through which the critic views our railway systems and scans their details can never be of sufficient power to reveal the barbed environments which circumscribed the actions of the time; nor can present analysis reveal the value then placed upon fragments of time or upon small amounts of capital. To seize quickly the golden opportunity, and bind it with the slender means within quick grasp, lines with rich prizes at the yonder end were often cut. Uncaught fish are of little worth when the craft that floats us must be quickly handled or be wrecked. Yet a critic might declare: 'A sad mistake was made right there.'

"No one of our great systems is the result of a carefully pre-arranged plan, but rather that of welding together of numerous fragments, either ready made, or built as the plans developed and as seemed expedient to the management in temporary control; straight links and crooked links, hooked together as they lay,—'tis a wonder they are so good; 'tis a pity they are so bad. The rapid growth of plans, the whirl of events, and the tremendous energy displayed in wresting vast territories from wild nature, and from the other fellow, form a history of intense activity, which may be but outlined by the most masterly hand. The mainspring of all this energetic activity was private gain, a feverish desire that the reaper should keep pace with the sower, as well as an ambition to lead in the race."

The ease with which corporations may be formed for legitimate purposes, and the ease with which personal liability is therein avoided; the way in which advantage was taken of these facilities to further various interests by the organization of railway companies—little and big—prior to the era of railway consolidation; the aid afforded by States, counties, and municipalities to such enterprises; the introduction of useless grades and detours to secure local aids; and how all these, and other things, though open to criticism from an engineering point of view, helped development,—are all brought out in this paper.

"Strangely (?) the original settlers were wonderfully successful in selecting just the proper site for a railway station, and villages seldom dared to refuse the required bonus 'in compensation for the trouble incident to a station inconveniently located.' Local aids were pledged to grade and tie the road; the right of way and grade was pledged to iron and equip it. Railway stocks went with the bonds as a makeweight; the acquired land grant was appraised low; railway stocks were sometimes made legal tender for land; and the syndicate seldom happened to take the poorest lands in theirs. Thus sowers raced, and reapers trod their heels;—small wonder there was haste." The building of new lines "to sell to one or the other company, many of them in the line of progress, but others vicious blackmailing schemes," is spoken of,—the latter class as retarding progress.

"The larger extensions are now usually succored by some large corporation, or by individuals therein having sufficient influence to secure their adoption by the company in good time. This is usually done with great secrecy, shrewd strategy, and many denials. Local corporations of small

pretensions are organized, by which contracts and deeds for right of way are taken, and for which locations of line are more or less perfected; local rivalries are skilfully stimulated; men of local influence are flattered by official places; communities and individuals are caressingly milked quite dry of rights of way and privileges; and sometimes monetary gifts are made, although the latter practice is becoming of ill repute. When the scheme is ripe, a new company is organized, into which all local companies are merged, from which the now useless dignitaries of local repute are excluded, and by which inconvenient pledges made by these dignitaries are often ignored. The child is adopted by the parent company, either openly, as one of the family, or covertly, as a poor relation on probation."

The struggle of rival companies is spoken of as "a war between giants, wherein treasure was poured out with a lavishness that sorely challenged the reputation for sagacity that some of our strongest men had won before, and which arms the anti-corporation howler with powerful weapons of attack. But the sketch of conditions of growth is sufficiently amplified to furnish, to stranger and to critic, the key to many riddles."

The duties of the chief engineer entail a burden of responsibility, but one in which he cannot always exercise his best judgment. His "judgment may be overruled arbitrarily by others, or by the force of circumstances; but such overruling leaves no trace of its action." He must be possessed of a rare combination of qualifications. "The quickly-formed mental estimate of cost is often strangely near the truth; the skill to make it is a faculty highly cultivated in some, and never acquired by a dullard. . . . It is not unusual for an imperative demand to come forth for an estimate to be completed within 2 or 3 days which, regularly calculated, would require as many weeks. 'A special meeting of financiers must consider the scheme at an early date,' or some such importunate circumstance seems always lying in wait to crowd the engineer. He must submit his best effort, upon which his reputation more or less depends, without show of hesitancy or discontent, or he incurs the odium of clogging the machinery by slow motion." Many of the most active locating engineers of former days spent years at the front, rarely meeting a fellow-craftsman or even seeing the work of other engineers; almost constantly remote from communication, and deprived of professional literature (aside from nature's volume and their own pocket note-book), with every day of their lives crowded with pressing duties. Brief calls upon their families, or from their wives, were the only comforts enjoyed during months of a life devoted to the stern demands of a calling arduous to the very extreme. . . . Many of the conditions met and conquered by force of original good sense and judgment were never met before, and still remain unrecorded. Much use of arbitrary formulas was made. A table used by many engineers in equating values of distance, curvature, and undulations is presented, followed by directions for its application to different conditions.

Passing interesting accounts of the organization and *personnel* of surveying parties; of the arduous duties and personal inconveniences of the locating engineer in field-work; of the rapidity with which constructive work follows that of location, of which the author says: "Location, construction, and finishing-grade stakes may all be urgently demanded of an engineer in a single day's work," and numerous complications caused by the necessity of avoiding publicity and various other influences; the method of defining right-of-way limits, acquisition of titles, and letting of contracts; the usual enterprise and skill of western contractors, often "better engineers than the men in charge"; the cost of various kinds of work, materials, and constructions, all of which are comprehensively treated in this exceedingly able paper, —we must close this review by quoting the eloquent language with which the paper concludes.

"From this outline of professional practice in the front ranks of scores of millions of struggling founders of a new civilization, preparing for them a way, do you

gather that our ways are crude and our practice rude? They are not more so than the dictates of uncontrollable circumstances compel. Kid-gloves and hair-splitting niceties have been eliminated, 'tis true, but brains, untiring energy, and physical powers have won the race. In the mighty rush of events which constitutes our domestic history, the coming of the railway engineer has been the first omen of the incoming tides of people, the first signal that a new channel for the bounding pulses of a young athletic nation was to be carved. His indomitable energy has made easy of access boundless treasures of wealth, locked in solitude since time began. Before him traditional deserts have vanished and bountiful harvests have followed closely behind. From his footprints bright visions of fond hopes realized have ever blossomed. New-found homes for eager multitudes have sprung into beauty along his path, and eager thousands have quickly clustered around the centers which his keen foresight has first discerned and marked.

"Nor has his pace been slow? Eight times in a century would it tame a wilderness of the combined areas of Great Britain, Ireland, France, Switzerland, Austria, Prussia, Spain, Portugal, Italy, and Egypt. The swiftest denizens of our plains have been surrounded, and fields of grain have hidden the trail of the savage before he found a refuge. The restless wiry 'peg-sticker' of our times has been a 'potent simple' in the magical charm which has won the world's brightest land of promise from an obscurity as deep as time has been long. He has been here; he is gone, and is well-nigh forgotten; but Chicago and scores of fair cities and immense regions filled with homes of comfort bedeck his pioneer way."

The Practical Use of Transition Curves.

THIS subject has been recently brought to the fore by numerous discussions, and articles printed in papers devoted to railroading. An article by Mr. Walter Loring Webb, in *The Railroad Gazette*, (May 24), is one of the most useful practical contributions yet made to the general fund. It contains responses to a series of queries sent out to chief engineers of leading American railways, to ascertain the extent to which the utilization of "the numerous systems of transition curves that have been proposed" has been carried. The following were the questions propounded:

"(1) Do you use transition curves? (2) Do you follow any of the published systems (Searles, Crandall, Wellington, etc.)? If not, will you state briefly the mathematical character of the curve used? (3) What is the lower limit of curvature on which you consider the curves necessary? (4) What rule regulates the relation of length to degree of curve? (5) What methods are employed to enable trackmen to maintain the track at the true curve? (6) Have you discovered any uniform tendency for the track to shift laterally in any one part of the curve? Is there any difference in this respect (on double track) between transition curves running *on* the curve or running *off* the curve? (7) Do the trackmen take kindly to the system, and take an interest in keeping the alignment true, or do they consider it an impracticable, theoretical refinement?

"About three-fourths of the answers received reported the use of regular systems in the transition curves. Of the others some reported the occasional use in special cases. One such answer was from a road that is remarkable for its easy alignment, and on this account the necessity for transition curves has never been urgent."

Mr. Webb classifies the answers to the second question into "three general systems. The C., C., C. & St. L. uses the Holbrook spiral, a system based on the 'true transition curve,' in which the curvature varies exactly as the distance measured along the curve. The 'cubic parabola,' more or less modified, is the most common. It is used on the Philadelphia & Reading, L. S. & M. S., N. Y., N. H. & H., and C., B. & Q. Searles's spiral (a system of compounded curves, of equal length and regularly increasing degrees of curvature) is used on the Nor. Pac. and on the Union Pac. The So. Pac. and the Mich. Cent. use systems of their own, which are also a series of compound

curves, but different in their details. The D., L. & W. uses the purely empirical method proposed by Trautwine in his book on railroad curves."

To the third question "the majority of answers gave 1°, 1° 30', and 2° as the lower limit. The Union Pac. uses spirals only on curves of 3° and over, and the Nor. Pac. on curves of 4° and over."

The answers to the fourth question show that from 50 to 300 ft. per degree of curve are used,—a very wide difference in practice.

Answers to the fifth question indicate that the difficulty in maintaining true curves has deterred "some roads from attempting transition curves at all, based on the argument that the track will very soon shift, and that nothing but an unreasonable demand on the engineering department will enable the trackmen to keep the track true. A few quotations on this point are significant. 'Track is laid originally to substantial track centers, which are easily found, if necessary, the centers being placed each 30 ft. on transition curves and each 50 ft. on main curves. Also, when originally ballasting, strong stakes are firmly driven to top of ballasted rail height, one stake 5 ft. each side of center, each 30 ft. on transition curves, and each 50 ft. on main curves. These stakes at once show any marked departure from true line, and they last for many years. When necessary, true line is retraced by transit and track relined, but it is not often required.' [So. Pac.] 'We set stakes—usually old angle bars driven 2½ ft. into the ground and marked on the top by a chisel mark—these stakes being set every 50 ft. Outside of our track we indicate the elevation to be given both at the beginning point of the spiral and at the place where the spiral and circular curve unite.' [C., C., C. & St. L.] 'We place monuments made of old rail at the points of curve and tangent of both the center curve and the easement curves, and we place intermediate stakes 50 ft. apart for the trackmen to line by as often as required.' [C., B. & Q.] The Philadelphia & Reading and also the N. Y., N. H. & H. use stone monuments placed at the beginning, center, and end of each elastic curve. Oak stakes, accurately centered, are placed at intermediate points. Nearly all the roads employing transition curves report the use of the above methods more or less modified."

As to the sixth question the "invariable answer" was that with transition curves the tendency to lateral shifting of track either in running on or running off curves is eliminated.

The answers to the seventh question are favorable to the maintenance of the curves; the trackmen find their total labor lightened, rather than increased, by a careful attention to the alignment.

Neither the Pennsylvania Railroad or the New York Central and Hudson River Railroad use transition curves, having apparently believed that they would be too difficult to maintain.

The Decline in Railway Charges.

THE great decrease in railway rates for transportation of merchandise; the tendency toward still further decrease, which railway managers would like to check, if they could, but which many of them believe is the "result of commercial laws which they have no power to restrain"; the necessity of devising further reductions without at the same time decreasing net revenue, on account of the "recent impetus which has been given to the construction of artificial waterways"; the governmental regulation of railways, and other points of vital interest to railroad men,—are discussed in *The Popular Science Monthly* for June, by Mr. H. T. Newcomb.

It was once maintained by men accepted as authority that wheat "would bear transportation only 250 miles to markets where it would bring $1.50 per bushel, and that the market for corn at 75 cts. per bushel must be within a radius of 150 miles from the point of production. To-day both of these products are carried from the great surplus-producing regions west of the Mississippi river and sold at much lower prices than those named, in order to supply the denser population located in the Eastern States and in Europe. Grain and

flour are now carried from Chicago to New York over railway routes ranging from 912 to 1042 miles in length, for 20 cents per 100 lbs., or only about 4⅓ miles per ton per mile for the shorter distance."

Dry goods, such as calicoes, flannel, canvas, linen crash, ginghams, jeans, and sheetings, are taken from Boston to Vicksburg, Miss., about 1570 miles for 50 cts. per ton per mile. The rate on canned goods, including fish, fruits, meats, and vegetables, from San Francisco to St. Louis over rail lines from 2280 to 2950 miles in length, is 75 cts. per 100 lbs., or about 1-2 cent per ton per mile. The author explains that these examples are "selected at random, and without any intention of showing the lowest charges in existence, as will be clearly apparent when it is added that the average charge upon all freight traffic carried by rail during the year was only 0.866 cent per ton per mile." The decrease has, however, been very gradual. There have been some marked changes, as is proved by statistics compiled from the last annual report of the Inter-State Commerce Commission, but, on the whole, the progress has been slow and steady.

From these statistics it is seen that the average railway capitalization "has changed but little. Gross earnings per mile decreased during the first half of the period, but have remained without material change during the last; or, in other words, the increased traffic has so far balanced the decrease in charges that the average gross revenue has not changed. Operating expenses have increased during the last 11 years, though during the period from 1871 to 1882 they showed a decline. The explanation is that during the first period increased density of traffic permitted economies in conducting transportation which had the effect of reducing the average cost to the carriers. It would appear, however, that a point was reached beyond which the institution of new economies could not keep pace with increased traffic at low rates, and that this had its natural effect in the second period. This explanation gains force when the constant decrease in average net earnings per mile is noted. Average freight and passenger earnings are seen to have fallen off considerably since 1871, and the final effect of these changes is summarized by the item of dividends, which are seen to be less than 50 per cent. of those paid during 1871."

While "more than double the freight transportation of 1884 is now performed for a total compensation less than two-thirds greater, ... passenger transportation has increased 18 per cent. more than the prices paid therefor," and capital invested in stocks of 176,000 miles of railway property is now receiving a smaller total dividend than in 1884 it received from 125,000 miles. In answer to the inquiry as to whether rates will go still lower, it is said that, while some think they are too low, and others think they will still decline, the author thinks it "obvious that the return to capital invested in railway securities must not be further reduced," and that, if reduction of rates continues, economies not now practised will have to be practised. It is also evident that the author looks with complacency upon possible government ownership, in the belief that "our institutions will be found perfectly adequate to the new task," should this appear to be necessary to harmonize the operation of the consolidated properties with the public interest. Aside from this view, which we believe to be fallacious, the paper of Mr. Newcomb is a good contribution to the railway literature of the month.

Efficiency of Compound Locomotives.

A PAPER on this subject read by Mr. F. W. Dean before the American Society of Mechanical Engineers, at a recent meeting, is printed in full in *The Railroad Gazette* (May 17). In this paper the statement is made that the numerous inferior designs for compound locomotives that have been produced of late have tended to create a reaction toward locomotives of the pre-existing type. Notwithstanding that this reaction has resulted in the change of some compounds to simple engines, Mr. Dean asserts positively that the compound system is not discredited among progress-

ive railroad men, and that "it is the greatest of all the economies that can be carried out on railways." The perpetuation and extension of the use of compound locomotives is predicted on the ground that there are a sufficient number now in use that are proving unobjectionable, and are "highly advantageous . . . . in many ways."

"There is nothing in which the expression 'survival of the fittest' will apply with more pertinence than to compound locomotives." Persons either possessing compound locomotives of the better class, or intimately acquainted with them, "never hesitate to say that they are the locomotives of the future, especially for freight, elevated-railroad, and suburban work. A type of engine that can clearly save fully one-quarter of the coal now used by simple locomotives; that materially reduces water consumption; diminishes boiler and slide-valve repairs; reduces smoke, cinders, and the fire risk; that steams better than the simple engines in hard places without a necessary increase of any kind of repairs, —must surely become the favorite as soon as people know which design to select."

The following are the reasons assigned for the asserted important saving of fuel. "(1) The steam can be more conveniently used with great expansion, and therefore high steam pressure can be more advantageously utilized. (2) Division of the expansion between two cylinders diminishes condensation to both cylinders by reducing the range of temperature in each cylinder. (3) Division of expansion between two cylinders renders it possible to evaporate, or re-heat, a portion of the moisture in the exhaust of the first cylinder, and thus render it capable of doing work in the second cylinder. As this can be done in the locomotive with waste gases, the gain is all profit. By using the proper kind of receiver, this is an effective means of economy. (4) Steam that leaks through the valve of the first cylinder is, in a properly-designed locomotive, worked expansively in the second cylinder. (5) Steam that is re-evaporated toward the end of the high-pressure piston stroke too late to work expansively, instead of being exhausted to the atmosphere, as in the simple locomotive, is worked expansively in the low-pressure cylinder."

Commenting and enlarging upon these propositions, the speaker said in substance, with reference to the first of them, that, while a short cut-off in a simple locomotive saves some fuel by lessening the effect of the exhaust on the draft, it is, at the same time, wasteful of steam. On the other hand, the compound locomotive saves 15 to 20 per cent. of the steam, and, above this, saves coal by its low terminal pressure in the exhaust.

As to the "fourth reason for economy," Mr. Dean stated that, "in some four-cylinder locomotives with a single valve to two of the cylinders, leakage may pass directly from the high-pressure cylinder, or even the boiler, to the atmosphere," so that this reason applies only to the two-cylinder compound.

Losses in compound locomotives are freely acknowledged; indeed, it was asserted that, in some compound locomotives, these losses have rendered them "more wasteful engines than simples." These losses arise from imperfections of the link-motion, which are strongly brought out in the high-pressure cylinder, from the large gap "between the bottom of the high-pressure and top of the low-pressure cards," and back pressure on the low-pressure piston.

"This discussion has brought out the fact that the compound locomotive is subject to losses to which the simple engine is not, and which may render it unfit for fast work. Such defects can, however, be fully overcome by large and easy passages, and the oft-repeated statement that the compound is fit only for freight trains is highly erroneous.

"From one point of view compound locomotives can be divided into classes,—*viz.*, the automatic, that starts by allowing live steam to pass to large cylinder only until the engine has made a half revolution, or thereabout; and non-automatic engines, that can be operated at will as simple locomotives as long as desired. I have always taken the position that the non-automatic engine does not allow the

compound system to fully realize its object, and that the locomotive which does not immediately become a compound after making an initial movement is to some extent a failure. It is held by the advocates of this type that the automatic engine does not start well, and that it cannot pull a sufficiently heavy train over ruling grades. Neither of these features have come within my experience, although that has been with freight trains on a continuous grade of 96 ft. per mile, 12 miles long, and with heavy fast suburban passenger work, with eleven stops in 9 miles. It is no exaggeration, in fact, to say that the starting of the automatic engine has been uniformly surer than that of the simple engine in this service. The point here considered is of the greatest importance in suburban or elevated-railroad work, for here the compound is particularly economical, if it is a compound from the beginning. If it is a simple engine for some little time, the greatest part of its peculiar adaptation to the work which requires frequent starting is lost."

Considering another classification of compound engines into two,- three,- or four-cylinder engines, Mr. Dean said that "the four-cylinder compound cannot be justified from an economical standpoint, and has no reason for existence except as a means for producing a balanced engine." An elaborate comparison of the relative adaptability and advantages of the compound engines for different kinds of service completes the paper. In the discussion by members that followed the reading, many instances of the economy of the compound system on different railroads were cited.

Effect of Pooling Agreements Upon Commerce.

AT the opening of the Detroit chamber of commerce on May 2 Mr. Geo. R. Blanchard delivered an address in which he justified pooling, intimated that popular opinion upon it is largely based upon ignorance of its true nature, and stated that, although it has been regarded adversely, its effects upon commerce are beneficial rather than the contrary. Reviewing the effects of pooling, Mr. Blanchard, whose address is reported in *The Railway Age*, said that, "passing over its failures and minor defects," the chief error of the Inter-State Commerce act "was that it refused railways the right by enforceable contract to maintain reasonable rates (as the act itself required) through the only effectual means yet found in the commercial world,—namely, pools, traffic unity, or joint purses." As to the effects of non-pooling, the speaker said that, "after 8 years with the act, it is public knowledge that serious irregularities continue, benefiting mainly large shippers, who, plus yielding railways, compel conditions which injure smaller senders, and places, and well-intending carriers, beyond their powers of resistance or correction. Law does not create rectitude, and the main agency to correct wrongs practised by carriers or shippers or collusively must be the railways themselves; but the act gave them no helps to that end, only mandates and penalties. Nevertheless, the pendulum of more intelligent public experience, thought, and conviction now swings more equitably, and no great commercial measure (the amendment or repeal of the act) has ever secured more support from former opposers, as witness these proofs. In '93 the senate referred the subject to the Inter-State Commission for reconsideration, whereupon it asked commercial bodies and others as to the advisability of amending the act so as to legalizing 'pooling contracts which would tend to diminish unlawful discriminations.' Eighty-nine answers favored so doing, or the entire repeal of the act. In June, 1894, the conference of commercial interests and trade bodies held in Washington adopted the following resolution: '*Resolved*, that competing common carriers may safely be permitted to make lawful contracts with each other for the apportionment of their traffic, or the earnings therefrom, provided conditions and restrictions be imposed which protect the public from excessive and unreasonable charges.'"

Many competent authorities have approved the system of pooling. The speaker cited decisions of the New York court of appeals and of the supreme courts of Mass-

achusetts and New Hampshire, and opinions of jurists and economists, to sustain this assertion; and added:

"I might stop here, and say that these many competent authorities have already studied and decided the commercial effects of pools; but, say our yet unconvinced friends: 'You ask congress to legalize trusts or combinations which will stifle competition and unduly advance rates.' And they inquire with triumphant logic: 'If railways do not intend these things, why do they desire pools?' Unlike trusts, we seek to extend, not curtail, reduction and facility, and we do not seek to enhance prices. Next, mark the clear distinction between reasonable rivalry and senseless strife; between stopping competition and regulating it; and between railway conditions and those affecting oil, corn, and iron."

The speaker quoted Prof. Hadley of Yale to the effect that there is but one alternative,—pooling or discrimination,—and added: "Answering the condition that we wish to advance rates, we desire to retain all legal sums which unchallenged fair tariffs, published as stipulated by law, require us to collect, thereby increasing our earnings by stopping preferential payments, needless reduced rates, unnecessary expenses. Moreover, if railways desired to advance rates unduly beyond proper tariffs, they could not do so more under pools than now. The rate-making power remains precisely the same." Further remarks citing illustrations of the benefits of pooling, among which the effects of the consolidadation of the telegraph companies by the late Mr. Jay Gould were conspicuous, concluded the address, which was very favorably regarded.

Interstate Commerce Statistics.

THE following statistics are taken from the seventh annual report of the interstate commerce statician, for the year ending June 30, 1894. This report may be referred to again in this department. It arrived too late for fuller excerpts in this number. It appears to be a very able and carefully prepared document, containing a large fund of valuable information relating to American railways.

Miles of railroad completed	178,708
Increase since June 3 , 1893, miles	2,247
Miles of track	233,533
Number of corporations	1,954
Locomotives	35,492
Cars	1,278,078
Employees	779,608
Decrease since June 30, 1893 (11 per cent.)	93 994
Capital stock (common)	$5,103,584,166
" " (preferred)	730,495,493
" " (total)	4,834,075,659
Funded debt	5,356,583,019
Current liabilities	605,815,135
Dividends, for the year	95,575,976
" average rate, on dividend paying stock	5.41
Gross earnings, year	$1,073,361,797
Decrease from previous year	147,390.077
Operating expenses	731,414,322
Decrease	96,506,977
Decrease in expenditure for M. W. p. c.	15.12
Decrease in expenditure for maintenance of equipment, p. c.	17 32
Net earnings	$341,917,475
Other income	142,816,805
Fixed charges, etc	429,008,310
Net, available for dividends	55,755.970
Employees killed	1,823
" injured	23,422
Passengers killed	324
" injured	3,034

This report covers the last four months of the Columbian Exposition; the remainder of the year the business depression had full effect. June 30, 1894, 192 roads were in the hands of receivers operating 42,000 miles and representing about one-fourth of the total capitalization. Fifteen roads (1,734 miles) have been merged, 22 roads (2,352 miles) reorganized and 14 roads (1,590 miles) consolidated. Over 56 per cent. of the total mileage is operated by 44 roads; 90 roads operate 82.9 per cent.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Railway Affairs in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

RAILROADING.

*31616. First Principles in Railroad Management. Benjamin Reece (Eng Mag–July.) 2800 w.

*31617. The Legislative Regulation of Railroads. Albert Fink (Eng Mag–July.) 5300 w.

*31618. Reforms in Railroad Management. Henry Clews (Eng Mag–July.) 3200 w.

*31619. Will Trunk Lines Be Operated by Electricity? Frank J. Sprague (Eng Mag–July.) 3000 w.

*31621. The Advance in Railroad Securities. Thomas L. Greene (Eng Mag–July.) 3000 w.

*31622. The Car Building Industry of the United States. John C. Wait (Eng Mag–July.) 4000 w.

We supply copies of these articles. See introductory.

*31623. A Glimpse of "The Silvery San Juan." Ill. T. A. Rickard (Eng Mag-July.) 3500 w.

*31624. The Modern Railroad Machine Shop. H. D. Gordon (Eng Mag-July.) 3000 w.

*31625. A Review of Railroad Invention. C. P. Mackie (Eng Mag-July) 3500 w.

†31672. The Economy of Colonial Railway Management (*Ind & East Eng*-April 13.) 3300 w.

31677. The Railroad Problem from a Shipper's Point of View. Charles W. Wells (Ry Rev-May 11.) 1100 w.

31678. An Improved Fastening for Steel Ties and Tie Plates.—Patent of E. H. Stone. Ill. (Ry Rev-May 11.) 1200 w.

31679. The Electric Railway for Interurban Traffic. Ralph W. Pope in Electric Power (Ry Rev-May 11.) 1800 w.

31687. Railway Building in Japan. Ill. (Ry Age-May 10.) 1200 w.

31726. Weight per Square Inch on Journals. E. W. Grieves (R R Car Jour-May.) 1200 w.

31727. Rule 8—Ad Libitum. George S. Hodgins (R R Car Jour-May.) 1800 w.

31728. Freight Car Doors and Fixtures.—Report of J. D. McIlwain. Ill. (R R Car Jour-May.) 1700 w.

31730. Painting, Paints and Varnishes as Applied to Railroad Equipment. (Abstract) G. W. Lord (R R Car Jour-May.) 1200 w.

*31735. Electric Locomotives for Railway Service. Ill. (*Ry Wld*-May.) 1100 w.

*31736. Some Links in Locomotive History. Ill. Clement E. Stretton (*Ry Wld*-May.) 1200 w.

*31737. A Locomotive with a History. Ill. Anon. (*Ry Wld*-May.) 700 w.

*31755. The Light Railways Bill (*Trans*-May 3.) 3000 w.

31781 —$1. The Industrial Services of the Railways. Emory R. Johnson (An Amer Acad-May.) 6000 w.

31797. The Financial Value of Street Railway Franchises. E. Ray Stevens, in the "Outlook" (Elec Rev-May 15.) 1200 w.

31825. The Efficiency of Compound Locomotives. F. W. Dean (R R Gaz-May 17.) 7400 w.

31826. A Gasoline Motor Inspection Car. Ill. (R R Gaz-May 17.) 300 w.

31827. The Effect of Negative Lead in Locomotives. Editorial (R R Gaz-May 17.) 1700 w.

31853. Effect of Pooling Agreements upon Commerce. George R. Blanchard (R'y Age-May 17.) 3500 w.

*31863. The Coming Railways of India and Their Prospects. J. W. Parry, with Discussion (*Jour Soc of Arts*-May 10.) 16500 w.

*31879. The Intercontinental Railway. W. D. Kelley (Stone-May.) 1800 w.

*31896. The Great Western Railway. Anon. (*Trans*-May 10.) 3500 w.

*31915. Railway Location and Construction as Practiced in the Western States. W. B. Lawson (Jour Asso Eng Soc-April) 7800 w.

*31916. On the Best Arrangement of Longitudinal Bracing for Timber Trestles. Ill. M. E. Yeatman (Jour Asso Eng Soc-April.) 2200 w.

*31920. The Metropolitan West Side Elevated Railroad of Chicago.—The Finest Elevated Road in the World. Ill. (St R'y Rev-May.) 4000 w.

*31921. Tramway Ambulance Service. Ill. (St R'y Rev-May.) 1100 w.

*31922. Electric Incline Railway at Great Falls, Montana. Ill. (St R'y Rev-May.) 900 w.

*31923. Geneva Street Railways. Ill. (St R'y Rev-May.) 700 w.

31936. Homely Advice.—A Brief Discussion of How to Ride in a Railway Train. (Humorous.) Chester N. Farr, Jr. From the Am. Law Register & Review (R'y Rev-May 18.) 3000 w.

31938. Regulations of State and Interstate Electric Railways. G. M. Woodruff (R'y Rev-May 18.) 1700 w.

31940. Notes on Pipe Electrolysis. Maurice Hoopes (Elec Wld-May 25.) 1800 w.

31948. Suspended Railway Systems. Ill. (Sci Am-May 25.) 900 w.

*31957. Test of Ithaca Street Railway Power Plant. Ill. Thomas McNeil and W. S. Manning (Sib Jour Eng-May.) 800 w.

31984. The Practical Use of Transition Curves. Walter Loring Webb (R R Gaz-May 24.) 1800 w.

31987. Organization of the Prussian State Railroads. Editorial (R R Gaz-May 24.) 1500 w.

*32053. The Railway Death Bill (*Trans*-May 17.) 1100 w.

32071. Schenly Park and Highlands Railway of Pittsburg. Ill. (St R'y Gaz-May 25.) 1300 w.

32073. Uniformity in Classification of Freights—Progress Toward It (R'y Age-May 24.) 1300 w.

32082. Fuel Saving on a Western Railway (R'y Rev-May 25.) 1400 w.

32083. Cause of the Uneven Wear of Driving Wheel Tires. Report of Committee (R'y Rev-May 25.) 900 w.

32084. The Use and Misuse of Socialistic Writing. Editorial on Article in Arena, with Abstract (R'y Rev-May 25.) 1400 w.

32133. Brick Arch Culverts: St. Louis, Keokuk and North-Western Railroad Extension. Ill. (Eng News-May 30.) 800 w.

32135. The Construction of the Boston Subway. Ill. (Eng News-May 30.) 4300 w.

32144. Chicago's Street Railway Mail Car. Ill. (W Elec-June 1.) 700 w.

32150. What is the Limit of the Passenger Capacity of a Suburban Track. Fr. von Emperger (R R Gaz-May 31.) 1400 w.

32151. Heavy and Hard Rails on the Boston and Albany. Ill. (R R Gaz-May 31.) 1800 w.

32152. Cold Storage Plant at Port Richmond, Philadelphia. Ill. (R R G-May 31.) 1600 w.

32153. The Railroads, the City and the Suburbs. Editorial. (R R Gaz-May 31.) 2500 w.

†32173. The Decline in Railway Charges. H. T. Newcomb (Pop Sci M-June.) 3000 w.

*32182. Railways and Harbors in New South Wales (*Trans*-May 24.) 1500 w.

32244. Railroad Patent Litigation—The Under Running Trolley. Ill. (Elec-May 29.) 5300 w.

†32269. The Street Railway System of St. Louis. Ill. (St R'y Jour-June.) 26300 w.

†32270. The Economy of Street Railway Cables. Ill. R. J. McCarty (St R'y Jour-June.) 3800 w.

*32274. Proposed Air-Brake Rigging, with Uniform Levers for all Classes of Freight Cars. Ill. B. Haskell (Loc Engng-June.) 2300 w.

*32275. High-Speed Locomotives. William Barnet Le Van (Loc Engng-June.) 2500 w.

*32277. Some Principles of Design. George S. Hodgins (Loc Engng-June.) 2400 w.

*32284. The Design of Cars and Locomotives Considered Architecturally. R. S. Atkinson (Nat Car Build-June.) 1600 w.

32299. A Portable Single Rail Surface Railway. Ill. (Sci Am Sup-June 8) 1400 w.

32303. 70000 lb Hopper-Bottom Ore and Coal Car; Pennsylvania Lines. Ill. (Eng News-June 6.) 1200 w.

32306. Equipping Freight Cars with Air-brakes and Automatic Couplers. Editorial (Eng News-June 6.) 2000 w.

32310. Additional Notes on the Efficiency of Compound Locomotives. F. W. Dean (R R Gaz-June 7.) 1000 w.

32311. The New York Railroad Construction Law (R R Gaz-June 7.) 1200 w.

32312. The Master Car Builders' Rules of Interchange. J. N. Barr (R R Gaz-June 7.) 4000 w.

32313. The Present Work of the Master Car Builders' Association. Editorial (R R Gaz-June 7.) 3200 w.

32316. The Pros and Cons of the Interchange Question. Editorial (R R Car Jour-June.) 2700 w.

32317. The Car Coupler Law About to Take Effect. Edward A. Moseley (R R Car Jour-June.) 900 w.

32318. The Life of Freight Equipment and Cost of Maintenance. A. M. Waitt (R R Car Jour-June.) 1800 w.

32319. The M. C. B. Scylla and Charybdis. George S. Hodgins (R R Car Jour-June.) 2500 w.

32320. What Shall Be Done with Our Interchange? E. W. Grieves (R R Car Jour-June.) 900 w.

32321. Progress in Metal Car Construction. J. D. McIlwain (R R Car Jour-June.) 1100 w.

32322. Foundation Brakes. Anon. (R R Car Jour-June.) 4800 w.

32323. Progressive Car Shop Practice. James F. Hobart (R R Car Jour-June.) 1600 w.

32325. M. C. B. Rule No. 8—Possible Results of Extension of the Principle of Car Owners' Responsibility. J. D. McAlpine (R R Car Jour-June.) 1800 w.

32331. The Growth of Transportation Facilities in Southwest Louisiana. W. W. Duson (Mfr Rec-June 7.) 1300 w.

*32341. The Westinghouse Quick-Acting Brake. Editorial (*Engng*-May 31.) 1800 w.

*32397. The Causes of Railroad Accidents. Julien A. Hall (Eng Mag-July.) 3000 w.

Serials.

24586. Railway Companies and Their Employés. O. D. Ashley (R'y Age-Began Aug. 24, 1894—11 parts to date—15 cts. each).

27603. A Treatise on the Construction of Railroad Rolling Stock. A. Flamanche, A. Huberti and A. Stevart (R R Car Jour-Began Dec. 1894—6 parts to date—15 cts. each).

28138. Block Signaling. Ill. W. H. Elliott (Loc Engng-Began Jan.—6 parts to date—30 cts. each).

28496. Electric Traction. Ill. Philip Dawson (*Engng*-Began Jan. 4—19 parts to date—30 cts. each).

28897. Motor Repairs. W. E. Shepard (St R'y Jour-Began Feb.—5 parts to date—45 cts. each).

29369. Tramway Management. By a Manager (*R'y Wld*-Began Feb.—4 parts to date—30 cts. each).

30604. Locomotive Repair Shop Equipment. W. H. Weston (Nat Car Build-Began April—3 parts to date—30 cts. each).

30654. Electric Railway Repair Shops. Henry P. Merriam (St R'y Jour-Began April—3 parts to date—45 cts. each).

31147. Mountain-Climbing Railways. Ernest Scott (*Elec Eng*-Began April 12—Ended May 31—3 parts—30 cts. each).

31211. The Stresses in Car Axles (R R Gaz-Began April 26—Ended May 24—4 parts—15 cts. each).

31293. State Railways in Western Sumatra. Ill. (*Engng*-Began April 19—Ended May 10—2 parts—30 cts. each).

31365. Boiler-Making. Ill. C. E. Fourness (Loc Engng-Began May—2 parts to date—30 cts. each).

31646. The Union Terminal Station at St. Louis. Ill. (*Engng*-Began May 3—Ended May 31—3 parts—30 cts. each).

31673. The Life of Railway Axles. Thomas Andrews (*Ind & East Eng*-Began April 13—2 parts to date—45 cts. each).

31738. Compressed Air Motors for Tramway Traction. Ill. H. Conradi (*R'y Wld*-Began May—1 part to date—30 cts).

SCIENTIFIC MISCELLANY

The Great Libraries of the United States.

OF these Mr. Herbert Putnam, librarian of the Boston Public Library, discourses pleasantly in *The Forum* for June, and points out certain tendencies, which have attracted little attention on the part of the general public. The present appears to be an era of library founding in the United States.

"During the past 13 years seven events have occurred which, either by the novelty of the ideas they represented or the magnitude of the interests they involved, have directed public attention peculiarly to one department of education. In 1882 the Enoch Pratt Library was founded in Baltimore; in 1887 the Newberry Library was founded in Chicago; in 1894 the Crerar Library was established in Chicago; and in the present year the new buildings of the Boston Public Library, of the Chicago Public Library, and of the Congressional Library will have been completed, and the consolidation of the Astor, Lenox, and Tilden Foundations will have been effected. Within the past few weeks, also, the superb gift of President Low makes it certain that the great new building for the Columbia College Library will be undertaken. These seven events have gained a popular prominence; but to them should be added certain others, which, although not perhaps as impressive in their immediate results, may prove even more far-reaching,—the work of certain State commissions, as in Massachusetts and New York, in extending State aid to the establishment of local libraries."

Mr. Putnam asserts that, "if not from the days of Alexandria, at least from the invention of printing down to the middle of the nineteenth century only one new type of library was added to those already existing,—the subscription library, whose creation was due to the simple sagacity of Benjamin Franklin. With the passage almost contemporaneously in England and in two of the United States of the enabling acts which authorized the formation of public libraries supported by general taxation, another new type was created. The act of Massachusetts was in 1848 (a special act—a general act followed in 1850); that of New Hampshire in 1849; that of Great Britain in 1850. The two libraries first to be established under these acts—the library of Manchester, England, and the library of Boston, both established in 1852—were the pioneers of this new type. Their example proved amazingly attractive, so that to-day the Manchester library is but of one of two hundred of its kind in Great Britain, and the Boston but one of more than nine hundred of its kind in the United States. The characteristics of those two libraries must, therefore, to some extent represent the characteristics of two entire groups."

The libraries of Boston and Manchester are both municipal institutions supported by general taxation. The municipal funds for purchase of books are expended primarily for books of general interest, and books for specialists are made secondary to the desire that popular reading shall be encouraged and promoted. To afford facilities for the general taste for reading which our public schools cultivate, and enable those who have such advantages to continue the cultivation thus begun at the public expense, was the principal purpose of their institution. "From the first . . . . the Boston library was adopted into a relation with the system of common-school education."

Mr. Putnam emphatically denies that such libraries are eleemosynary institutions. "The public library in the United States . . . was created by and for a people wonted to the notion of a free-school system. In making use of it, they feel as little the objects of charity as they do in sending their children to the public schools. In both cases they are the patrons, not the beneficiaries. More than this, they have a sense of ownership in,

and control over, these institutions."

The intent was to "*supplement* the work of the common school"; but a movement "not then foreseen . . . is now enabling the public library to complement" that work. "As a result of this movement (developed under the leadership of the Worcester, Mass., Public Library) the schools draw directly upon the library for books to be used in class work; so that the library is woven in with the whole system of common-school education."

"It was the establishment, in 1876, of the American Library Association and of the '*Library Journal*,' and of a series of annual conferences of librarians, that both induced concerted effort and rendered it possible. And systematic training is now represented in the United States, in the first place by seven library schools (that of the New York State Library, that of Pratt Institute, Brooklyn, that of the Drexel Institute, Philadelphia, that of the Armour Institute, Chicago, and those of the Denver and of the Los Angeles Public Libraries, and that conducted during the summer at Amherst, Mass.), and in the second place by courses in bibliography and library economy, now forming part of the regular curriculum in various colleges (Amherst, Bowdoin, California, Colorado, Cornell, Iowa, Maine, Michigan, Wellesley)."

The tendency to increase the facilities for prompt access to books in libraries is one of the features of modern library development. "Whether or no it be true abroad, it is certainly true in the United States that such measures as have been taken to strip library administration of its formalities, and to render access to the books easier and more direct, have been taken under the initiative of the librarians themselves. If there has been any reluctance to do away with formalities, it has been on the part of persons who, not being brought into close and daily contact with the reading public, as is the librarian, cannot realize as he does that it is the specialist, who by education has the greatest respect for literature, who is apt to show the least respect for books; and that the library, if it suffer depredations, suffers least of all from the ordinary reader, who, without knowledge to induce so great a respect for literature, is guarded by a greater reverence for books. A small library, with a small body of readers, may without difficulty permit direct access to its books. As the library grows and readers become more numerous, the books are apt to be drawn farther and farther away, and catalogues substituted in their place. After years of effort in the endeavor to devise perfect systems of cataloguing, our libraries are now trying, as far as possible, to substitute for the catalogue personal mediation and direct contact with the books. It is felt that, unless this can be effected, large libraries will lose some of the agencies for good which small libraries possess."

A Cable Post.

AN article by J. Henniker Heaton, M.P., in *The North American Review* for June, discusses the possibilities of Atlantic submarine communication under the title, "A Cable Post." Those who care to learn how an English parliamentarian regards the facilities now afforded by cables between the two continents will find it a very readable paper.

"Why has this grand experiment, on which we grown men looked, as boys with breathless interest, proved a miserable failure? The obvious explanation is that a shilling a word is a prohibitive rate, which can only be borne in the small class of transactions yielding extraordinary profits, or under the pressure of sheer necessity. If a man with a business of moderate dimensions corresponds with London customers by letter, knowing that his wealthy rivals habitually employ the cable for the same purpose, it is not because he prefers a week's delay, but because he cannot help himself. On the other hand, capitalists would be glad to have the rate five dollars a word, in order to kill the competition of poorer men. Yet even rich men writhe a little in the grip of the cable companies; and this is why 97 per cent. of the messages are sent in code. The proportion of social mes-

sages exchanged between relatives and friends on matters of private concern—only 3 per cent.—is so small as to be hardly worth taking into account at all."

The control of the Atlantic cables is in the hands of "a monopoly." "Strictly speaking, it is a duopoly, for there are two groups of share-holders interested; but these two maintain a common tariff," and "all the evils of a monopoly exist. . . . The true culprits are the British and American governments, which have allowed private persons to undertake State responsibilities and to intercept benefits that belong to the public at large."

"Nominally six companies carry on the trans-Atlantic cable traffic,—namely, the Anglo-American Telegraph Company, the Western Union Telegraph Company, the Commercial Cable Company, the Direct United States Cable Company, the American Cable Company, and the Paris and New York Cable Company. Of these, however, the American Telegraph and Cable Company is (according to *Burdett's Intelligence*) leased to the Western Union Telegraph Company, and the Anglo-American Telegraph Company receives 48 825 per cent. of the receipts of four companies,—namely, the Direct United States Cable Company, the Paris and New York Cable Company, and the American Telegraph and Cable Company (now leased, as stated, to the Western Union Telegraph Company). It is clear, therefore, that competition is practically confined to the Anglo-American Telegraph Company and the Commercial Cable Company, the former of which controls nine cables (five of its own and four of its allies), while the latter has three at its disposal."

The total capital invested in these companies is about $60,000,000, on which handsome dividends are paid. "The number of words sent over the cables between America and England last year was 23,000,000. Of these 20,000,000 were business messages at 1s. per word, and the balance, 3,000,000, were messages at 5d. per word. Deducting some small charges, the total income from Anglo-American cables may be put down at $5,000,000.

"Now, by means of the recent improvements, forty-five words per minute can be sent over one wire, so that the twelve cables might be employed to send in 1 year no less than 283,824,000 words! It must be remembered, however, that only two of the twelve cables are extensively employed. Indeed, a cable expert of high authority is of opinion that the new cable of the Anglo-American Company, having a weight of 400 lbs. of copper to the mile, is of sufficient capacity to carry all the existing traffic."

The extensive use of codes has some curious features. "One man is known to have paid £3000 for a good code. These codes are sometimes over-significant. Thus the word 'man' might mean 'Readings declined one-tenth.' 'Penns. rose-one-fifth,' and 'New York Central steady.' And again the word 'wormlike' means in one code: 'The price is 10s.; appearing high as compared with your market. We took refusal until to-morrow, and shall buy unless you immediately instruct us to the contrary.' This message of twenty-eight words was sent as one word, to the disgust of the shareholders and managers of the cable companies. No code can properly anticipate a social or family message. Such codes as have been prepared are rarely used, for it is difficult to prepare a cut-and-dried programme of the diversified events of daily life. An attempt was made some years ago to charge double and treble for code words. But the merchants were too clever, and an apparent social message, such as that 'John married Eliza,' often conveyed the most recent market rates for corn."

Mr. Heaton asserts that the public pays £1,000,000 a year for what could be supplied at £130,000, and that, if the cables were destroyed, the present facilities could be constructed for £6,000,000; and he proposes "that the British and American governments should jointly acquire the properties and rights of the existing companies at a fair valuation, and establish a common State monopoly in cable communication." This suggestion is likely to be earnestly considered and advocated in the near future.

The Scientific Uses of Liquid Air.

THE discovery of Prof. Dewar by which air may be quickly and readily liquefied in quantities sufficient for use in scientific investigations seems calculated to add largely to the store of scientific facts. *The Electrical Review* (May 3) says: "To make a scientific discovery is one thing; to apply it to the arts or industries is distinctly another. It is often much more difficult to realize the scientific and economical bearing of a fact than it is to find it out. Prof. Dewar seems to combine within himself that faculty rarely found in scientific men, —namely, of knowing what to do with his discoveries when he has made them. This we contend is the highest attainment. A man who simply amasses data and knows not how to deal with them is in the position of one who, possessing the wit to accumulate money, is incapable of using or enjoying it."

A statement of the applications of liquid air already made shows that the belief above is by no means chimerical. "Speaking generally, the chief scientific uses of liquid air consist in the facilities it gives for the study of the properties of matter at temperatures approaching the zero of absolute temperature. For a number of purposes it does not matter whether liquid air or oxygen is employed. Prof. Dewar, who has been working in conjunction with Prof. Fleming, appears to have used these substances almost indiscriminately, and the experiments made have largely partaken of a qualitative character. This, however, was in the nature of things, for investigations on the properties of matter at the temperature of boiling liquid air must necessarily, in the first instance at least, be largely qualitative rather than rigidly quantitative.

"In the science of optics, in the study of specific heats and of the cohesive forces, of modifications in chemical affinity and of magnetic conditions at low temperatures, liquid air has already been the means of attaining facts; and facts are always valuable, though a true estimate of their value often comes long after their first discovery. So far, the experiments which have been carried out seem to point to, if not warrant, the conclusion that at the zero of absolute temperature all the pure metals would be perfect conductors of electricity. Under such conditions a current of electricity started in a pure metallic circuit would develop no heat, and therefore undergo no dissipation. Similarly it may be inferred that there would be no Peltier effect at the zero; in other words, the passage of electricity from one metal to another would take place without evolution or absorption of heat. Liquid air is stored in glass vacuum vessels, which are either cylindrical or spherical in shape. Hence these vessels can act as lenses. This fact facilitates the examination of the refractive indices of liquid nitrogen and air. . . . For some time Prof. Dewar has projected a series of observations on the thermal capacity of liquid oxygen and nitrogen, but the difficulties inherent to the task have barred the way. He has now succeeded in using these glass vacuum vessels containing liquid gas for the purpose of determining approximately the relative thermal transparency for heat of high refragibility. Liquid oxygen appears to be one of the most transparent liquids known in relation to heat. The results obtained, although probably only approximating to the truth, may be regarded as confirmatory of the inferences Tyndall drew as to the relation between gases and liquids as absorbents of radiant heat.

"By a beautifully simple device Prof. Dewar succeeds in storing liquid air so that it shows no signs of ebullition, the surface remaining as quiet and still as if it were ordinary water. This is accomplished by silvering the interior and exterior of the vacuum vessels, a little excess of mercury being left, so that, in the act of filling the inner vessel with the liquid air, the metal is deposited as a fine silvery film."

The Volterra Alabaster.

WHILE in various localities in Southern Europe stones exist that are of nearly the same chemical composition as the alabaster of Volterra, and some which are called alabaster by courtesy, although their composition is different, the *Journal of the*

Society of Arts (May 24) says they are of such poor quality as compared with that obtained in the district of Volterra as to leave the latter without a rival. The alabaster spoken of in the Bible was a species of marble. The alabaster of Volterra is a hydrated sulphate of lime, and is asserted to be found in a condition fit for the production of the highest class of alabaster work nowhere in the world except in the province of Pisa. Of course this refers to what is now called alabaster, not the scriptural alabaster—a species of marble—of which boxes for fragrant ointments and for other purposes were made. The ancient Etruscans made cinerary urns of the same material that is now called alabaster. Many of these may be seen in a local museum in Volterra, which was one of the twelve cities of the Etruscan League. This review will take the form of a running abstract of the article named, exhibiting features of an industry little known outside the district in which it is carried on.

The alabaster districts may be divided into two parts. In the first may be included all the caves (the word "caves" more accurately describing the nature of the workings, which are subterranean, than the word quarries) lying round about Volterra. The second division is composed of the communes of Castellina and Santa Luce, where, in the valley of the Marmolaio, are situated on the left bank the historic caves of Castellina, and on the right bank the less known, but equally important, caves of Pomaia. The reason of this division is that the alabaster of the caves of the Marmolaio valley, which, following the custom of the dealers and workers of Volterra, is called Castellina alabaster, has a whiteness, a purity, and a transparency not to be found in the alabasters of the other communes, and because it, and it alone, is used in that flourishing branch of the industry which is devoted to the sculpture of figures. There are many different varieties of alabaster found in the whole district. Dr. Targion Tozzetti, writing 100 years ago, has elaborately described fifty-two, but it will be sufficient for all practical purposes to divide the whole class into five clearly-defined species, as follows: the white alabaster of Castellina, a luminous and transparent stone of faintly cerulean tint; the white alabaster of Volterra, a mineral of an opaque, milky, and even cream-white color; veined, striped, or spotted alabaster, in its many fanciful and beautiful varieties; *bardiglio*, a greyish stone of the nature of alabaster, which, when cut and polished, has somewhat the appearance of the grey marble known as "dove" in the English trade; and, finally, the agatized alabaster, called at Volterra *agata*, an extremely beautiful and yellow stone, varying in color, when polished, from dark amber to deep, rich brown. The *bardiglio* is the cheapest, and the *agata* is the rarest and most expensive, species of alabaster.

The Castellina alabaster is especially prized on account of the large size of the blocks found. Nearly three-fifths of the alabaster for sculpture which is excavated at Pomaia is in blocks weighing at least six cwt., while blocks of from seventeen to twenty cwt. are of common occurrence. A block weighing 58 cwt., and having a length of 5¼ ft., was sent to the late Antwerp Exhibition. Working in the caves appears to be healthy; the workers all live to a good old age. They have a belief that the fine white alabaster powder has strong hygienic properties. The worked alabaster industry is divided into two strongly differentiated branches: first, sculpture,—that is, sculptured representations, whether on a large, or small scale, of the human form; and, second, the miscellaneous industry. This latter comprises objects manufactured at Volterra, such as vases, ewers, pillars, stands, baskets, clock-cases, frames, toilet necessaries, animals, fruits, ash-trays, candelabra, crucifixes, holy-water stoups, etc. Nearly all the best sculpture of alabaster is now carried on in Florence; the miscellaneous industry is almost confined to the city of Volterra.

In former days there were three distinct classes of workers,—the master artist or worker who owned a large workshop, employed numerous workers, and sold his products direct to the alabaster shops, or

galleries, as they are called, of Leghorn, Pisa, Florence, and Volterra; the journeymen workers; and the travelers,—men who travelled not merely with samples, but with huge cases of the goods, selling them as they went along. The master worker and the traveller are now extinct species. The modern system of labor and distribution is entirely different. Walking along the by-streets of Volterra, the ear is arrested by the clinking of little hammers or the grating rasp of files; and, looking at a doorway, the passer-by will see two or three men busily engaged with all the application of true artists in fashioning the various parts of a vase or a flower-basket. These men may be a father and his sons, or three men united in an informal partnership, and they usually unite in themselves the manual skill required for the production of a vase, one being a turner who gives it shape, another a modeller who fashions its pillar and base, and the third a decorator who carves its adjuncts of fruit and flowers. The master worker, with his busy band of workers and apprentices, has disappeared, and the articles named come from these small shops.

Preserving Wood and the Haskinizing Process.

YEARS ago a process of seasoning timber and rendering wood more resistant to the action of atmospheric influences, as well as less liable to the attacks of insects, by treating it with steam and bringing it to a temperature at which coagulation of the coagulable substances contained in it is effected, attracted some attention. It was found that wood could thus be seasoned, and its resistance to decay increased. Some thought, however, that the strength of wood thus treated was inferior to that slowly seasoned in the old way. The wood, taken out while hot, had thus parted with much of the water holding in solution the non-volatile substances in the sap, and the residual heat quickly dried it, enabling the process of seasoning to be completed in little more than the time necessary for putting the wood in the apparatus, heating it throughout its texture to the desired temperature, taking it out, and finally cooling it down to normal temperature in the open air and in a dry place.

No one thought that retaining the water contained in the sap during the heating could be of any benefit, since its evaporation cannot be rapidly effected by heat without at the same time producing the desired coagulation. However, the retention of the water of the sap in the wood during the heating process is now claimed to be the explanation of alleged improvement of quality in "vulcanized wood" obtained by a process called Haskinizing, described in *The Marine Engineer* (May 1). The inventor of this process, Colonel Haskin, has been exhibiting wood treated by it in London. While it is claimed that the wood is thus protected from decay, special claims that it is handsome in appearance, easily worked with tools, and free from any offensive odor are also made. The process, it is stated, is conducted in a cylinder made of boiler-plate sufficiently strong to withstand an internal pressure of super-heated circulating air compressed to several atmospheres, for the purpose of holding the fluids of the wood from evaporation. The wood is piled on cars, which are run into the cylinder, and the air is pumped from a large compressor into the cylinder, after it has passed through a small stove or furnace, so as to become super-heated.

The air pressure holds the sap or fluids in the wood, effectually preventing their evaporation, while the intense heat passing through and clear to the centre of the timber, so sublimates and attenuates the fluid matter of the wood that a new compound is formed, or, rather, the constituent elements of the sap are thus caused to enter in combination with one another, which, under lower degrees of heat, are distilled or desiccated separately.

It is claimed that the ingredients hitherto distilled out of wood by various processes of treatment are valuable antiseptics, and should be retained in the timber. There does not seem a chemical warrant for this claim, and, even if there were, it is not obvious how their evaporation is prevented by the use of hot air, more than by steam at an equal temperature.

THE TECHNICAL INDEX—1895.

Current Leading Articles on Various Scientific and Industrial Subjects in the American and English Technical Journals—Abbreviations are clearly explained in the Introductory.

*31660. The Scientific Uses of Liquid Air. Ill. (*Elec Rev*-May 3.) 2000 w.

†31731. Color Shadows. A. E. Wright (*Nineteenth Cent*-May.) 5600 w.

*31762. A New Wood Preserving Process (*Marine Eng*-May.) 700 w.

*31772. Air-Tight Steel Storage. L. LaRue Smith (Milling-April.) 1500 w.

†31775. Some Physical Aspects of the New Gas, Argon.—The Ideal Thermo Metrical Substance for High Temperatures W. R. Quinan (Jour Am Chem Soc-June.) 2000 w.

†31777. Danish Butter-Making. Ethel B. Tweedie (*Fort Rev*-May.) 6500 w.

31778.—$1. Uniform State Legislation. Frederic Jesup Stimson (An Amer Acad-May.) 12500 w.

31810. Lake Basins Created by Wind Erosion. G. K. Gilbert (Sci Am Sup-May 18.) 800 w.

31812. Summary of Conclusions of a Report by Drs. D. H. Bergey, S. Weir Mitchell and J. S. Billings upon "The Composition of Expired Air and Its Effects upon Animal Life." (Sci Am Sup-May 18.) 2000 w.

31814. Some Reminiscences of Frederick E. Sickles. John T. Hawkins (Am Mach-May 16.) 3000 w.

*31835. The Story of Human Progress (Self Culture-May 15.) 800 w.

31891. A Hole Nearly a Mile Deep —One of the Novelties of the Next Paris Exposition (Bos Jour Com-May 18.) 1500 w.

*31917. The Relation of Technical to Liberal Education. C. M. Woodward (Jour Asso Eng Soc-April.) 6400 w.

*31918. The Manufacture of Cement from Furnace Slag. Hermann Crueger (Jour Asso Eng Soc-April.) 3000 w.

*31950. The Scientific Progress of the Nineteenth Century. Dr. Paul Carus (Chau-June.) 3000 w.

*31961. Chicago before the Fire, after the Fire and To-day. Ill. Melville E. Stone (Scrib M g-June.) 4000 w.

*31962. The Bicycle. Ill. I. The Wheel of To-day. Philip G. Hubert, Jr. II. Woman and the Bicycle. Marguerite Merington. III. A Doctor's View of Bicycling. J. West Roosevelt (Scrib Mag-June.) 12500 w.

†32010. Engineering Facts vs. Credulity. George Y. Wisner, in "The Technic" (*Ind & East Eng*-April 27.) 2000 w.

*32050. Means for Mitigating the Fading of Pigments. W. de W. Abney (*Jour Soc of Arts*-May 17.) 4500 w.

*32056. Terrestrial Helium (*Nature*-May 16) 2200 w.

*32078. The Natural Basis of Decorative Art. Charles L. Condit, in Painting Decorating (Arch, Build & Dec-March.) 3000 w.

†32091. Argon. Résumé by E. Waller (School of Mines Quar-April.) 1700 w.

32108. The Moon's Story. Robert Ball (Sci Amer-June 1.) 2800 w.

32110. The Stained Glass Window Industry. Ill. (Sci Amer-June 1.) 900 w.

†32113. Daily March of the Wind Velocities in the United States. Frank Waldo (Am Jour Sci-June) 4000 w.

†32114. A Newly Discovered Dike at De Witt, near Syracuse, New York. Geologic Notes by N. H. Darton. Petrographic Description by J. F. Kemp (Am Jour Sci-June.) 2500 w.

†32115. Note on the Amount of Elevation Which Has Taken Place Along the Rocky Mountain Range in British America Since the Close of the Cretacious Period. G. M. Dawson (Am Jour Sci-June) 900 w.

†32215. Remarks on Daimonelix, or "Devil's Corkscrew," and Allied Fossils. Ill. Joseph T. James (Am Geol-June.) 1500 w.

†32216. A Contribution to the Geology of the Coast Ranges. Andrew C. Lawson (Am Geol-June.) 4500 w.

†32217. Canadian Localities of the Taconic Eruptives. N. H. Winchell (Am Geol-June.) 2500 w.

†32218. Recent Contributions to our Knowledge of the Cladodont Sharks. E. W. Claypole (Am Geol-June.) 1600 w.

†32219. Auriferous Gravels of the Sierra Nevada. H. W. Turner (Am Geol-June.) 2500 w.

*32259. Engineers of To-day and Yesterday. Thomas Bell Lightfoot. Ill. (*Eng Rev*-May 20.) 900 w.

*32268. The Great Libraries of the United States. Herbert Putnam (*Forum*-June.) 5000 w.

†32281. The Work of the Sanitary Engineer in Time of Epidemics, in Time of War, and in Sudden Calamities in Civic Life. William Paul Gerhard (San-June.) 5500 w.

Serials.

24462. Graphic Statics. Ill. W. W. F. Pullen (*Prac Eng*-Began Aug. 10, 1894—19 parts to date—30 cts. each).

27198. Refrigerating and Ice-Making (Sta Eng-Began Nov., 1894—6 parts to date—15 cts. each).

29531. A History of the Last Quarter-Century in the United States. Ill. E. Benjamin Andrews (Scrib Mag-Began March—4 parts to date—30 cts. each).

31852. The Liquefaction of Gases.—Review of series of lectures by Prof. Dewar (*Eng*-Began May 10—2 parts to date—30 cts. each).

32220. Composition of the American Sulphur Petroleums. Charles F. Mabery (Jour Fr Inst-Began June—1 part to date—45 cts).

We supply copies of these articles. See Introductory.

NEW TRADE CATALOGUES.

McIntosh & Seymour, Albany, N. Y., U. S. A.=Catalogue, 40 pp., 10¼″×8½″. [Describing and illustrating a fine line of automatic cut-off engines of different types. Elegantly printed; cover, robin's-egg blue, embossed.]

H. E. Collins & Co., Pittsburg, Pa., and Chicago, Ill., U. S. A.=Pamphlet, 45 pp., 5¾″×7½″. [Describing and illustrating the "Cahall" Vertical Water Tube Boiler. The pamphlet discusses the requirements of a perfect steam boiler. Beautifully printed and profusely illustrated throughout. Cover, blue and gold.]

Henry R. Worthington, New York, U. S. A. =Pamphlet, 36 pp., 5″×6½″. [Illustrating and describing the Worthington water meter, with an introduction discussing the requirements of good water meters. Also containing hydraulic tables and much useful information relating to the subject of water-supply in cities. Nicely printed and illustrated; cover, red and black.]

Henry R. Worthington, New York, U. S. A. =Pamphlet, 24 pp., 5″×6½″. [Describing the Worthington steam pumps for brewery and distillery service. The description is confined to pumps for these special uses. Nicely printed and illustrated; cover, red and black.]

The Kinnear & Gager Co., Columbus, O., U. S. A.=Catalogue, 32 pp., 11½″×8½″, with leaflet containing price-list. [Illustrates and describes interior decorations consisting of interior metal work, ceiling and rolling metal partitions, doors, shutters, etc. This is one of the handsomest catalogues received this month. Cover, French gray and gold.]

Pencoyd Iron Works, Bridge and Construction Department, Pencoyd, Pa., U. S. A., 20 pp., 6¼″×10″=General Specifications for Railroad Bridges. Cover, robin's-egg blue and black.

F. E. Brandis' Sons & Co., Brooklyn, N. Y., U. S. A.=Illustrative and Descriptive Catalogue and Hand-book, 236 pp, 5¾″×8½″. [Illustrates and describes instruments of precision for civil engineers, surveyors, and astronomers, made by this firm. Besides descriptions of the instruments, the book contains a very large amount of useful information relating to the general use of such instruments, with mathematical explanations of the principles upon which they are based; it is, therefore, a valuable book to be placed in any engineer's library. Flexible cover, yellow and black. Price, 50 cts.]

Wrought Iron Bridge Co., Canton, O., U. S. A.=Pamphlet, 73 pp., 5¾″×4½″. [Describing and illustrating a great variety of work which has been executed by this company. The illustrations are half tone, beautifully printed, and include exterior and interior views of the works of the company, as well as structures erected by them. Cover, salmon yellow and black.]

The Huyett & Smith Mfg. Co., Detroit, Mich., U. S. A.=Catalogue, 138 pp., 6¾″×10″. [Describing and illustrating a long line of dry kilns, brick dryers, hot blast heating apparatus, ventilating fans, blowers, engines, marine water-tube boilers, cotton fans, exhaust fans, steam traps, blast gates. Beautifully printed on coated paper; cover, salmon yellow and red.]

Charles D. Mosher, No. 1 Broadway, New York, U. S. A.=Pamphlet, 35 pp., 4″×6¼″. [Discusses the subject of steam separators in a general and practical manner, and describes and illustrates the Mosher Steam Separator. Cover, French gray, red, and indigo blue.]

Samuel J. Shimer & Sons, Milton, Pa., U. S. A.=Catalogue, 140 pp., 7½″×10½″. [Describes and illustrates a great variety of the "Shimer" cutter heads for general wood working and the manufacture of flooring, ceiling, siding, wainscoting, ship-lap, O'G siding, plain jointing, glue jointing, sucker rods, hoops, trunk slats, blind slats, blind rods, flush door moulding, O'G doors, sashes, blinds, cope heads to match dado heads, and special tools for all accurate work with full-sized representations of wood patterns as made by these various tools described in the catalogue. This is a very complete and elegant book, nicely printed on coated paper; cover, robin's egg blue and black.]

The Taunton Locomotive Mfg. Co., Taunton, Mass., U. S. A.=Catalogue 63 pp, 8″×10″. [Describes with 25 illustrations the various forms of the Wainwright appliances, viz., feed, water heaters, surface condensors, and expansion joints. (2) Leaflets, describing the Wainwright expansion joints with size and prices, and price list of the Wainwright water tube heaters and Wainwright steam tube heaters.]

M. C. Bullock Mfg. Co., Chicago, Ill., U. S. A =Catalogue No 27, 3d Edition, 37 pp., 7¾″×10½″. [Describes and illustrates, with beautiful half-tone engravings, the Central Valve engine manufactured by this company. One of the plates is an illustration of the Gunning & Campbell engine at Belfast, and another a representation of the large mill engine operating the cotton mill for Mr. Thomasson and Son of Boulton, Eng. A noticeable feature of the catalogue is a letter and curves representing result of a test of a Siemans-Willans set for Glasgow corporation, Siemans' dynamos II, B. 27·40, shunt wound No. 3053. Willans engine III, Central-valve compound No. 1533. These curves give the indicated horse power and electric horse-power, the number of amperes at 225 volts and the percentage efficiency.]

The New York Central Iron Works Co., Geneva, N. Y., U. S. A.=Pamphlet, entitled "Steam and Hot Water Heating by the Dunning Boiler." 16 pp., 3¼″×6″, with folding plates.

The C. W. Hunt Co., New York, U. S. A.= Pamphlet 30 pp, 6½″×9¼″, entitled "Manila Rope for Transporting and Hoisting." [A brief treatise for engineers' on ropes used for the transmission of power, and for hoisting falls—together with formulæ, tables and other particulars useful in mill engineering. The pamphlet is beautifully printed with half-tone illustrations and line engravings. Cover, French grey and black. (2) Envelope containing useful tables printed on paper with gummed backs for convenient insertion in memorandum books. This is a very neat device which will be appreciated by a great many engineers.]

The Jeffrey Mfg. Co., Columbus, Ohio, U. S. A.=Catalogue 144 pp., 5″×7½″. [Describing chain belting, elevating, conveying, power transmission machinery, steam cable conveyors, labor saving appliances, etc. A very handsome catalogue well and profusely illustrated. Cover, pearl gray and blue.]

The Lackawanna Lubricating Co., Scranton, Pa., U. S. A.=Pamphlet unpaged, 7″×5⅜″. [Contains an Essay on Locomotive Cylinder Lubrication, with a description of the Cylinder Lubricators manufactured by this company. A full detailed description of the Lubricators, with engravings illustrating all their parts and their operation, is comprised in the pamphlet; also a certificate from the committee on science and the arts of the Franklin Institute, confirming the advantages of this lubricator and stating them in detail.]

William A. Nicholls, Philadelphia, Pa., U. S. A.=Pamphlet No. 7½″×10″, Pages not numbered. [Describes and illustrates the Barnes Portable Highway and Railroad Culverts. This culvert is built of steel or iron plates and shapes, with a trapezoidal cross-section, and angle iron bracing. The advantages are fully set forth in the pamphlet.]

Bayne, Wilson & Pratt, Pittsburgh, Pa., U. S. A.=Pamphlet 156 pp., 7″×10″. [Some Things That Have Been Written About Farrar & Treft's Machinery, Morris Tasker & Co.'s pipes, the Annealed Steel Coupling and the Palm Link, 1878-1895. [A reproduction of advertisements that have appeared in the *Bradford Era* and *Oil City Derrick* from 1878-1895, illustrated with portraits of many notable men, and also with comic illustrations which have accompanied the advertisements. The whole is printed on coated paper of good quality and handsomely bound in paper. Cover, pearl gray and brown.]

Sullivan Machinery Co., Chicago, Ill., U. S. A.=Catalogue, 80 pp., 7″×10″, 1894. [Describes and illustrates a great variety of the Sullivan diamond prospecting core drills. Full directions as to the erection and use of the machines are also supplied. A price-list is also comprised. Appended are descriptions of portable boilers, mounted on wheels, vertical boilers with submerged tubes, the "Eureka" sectional safety boiler, Blake steam pumps, Knowles' steam pumps, the Metropolitan Injector, for locomotive boilers, flue cleaners, portable forges, pipe-fitters' tools, coal-mining machinery, etc. This is a very fine catalogue indeed, well printed and illustrated. Cover, black and red.]

The Dunn Mfg. Co., Limited, Pittsburg, Pa., U. S. A.=Catalogue, unpaged, 6″×9″. [Describes and illustrates the extensible sewer brace manufactured by this company, and also a line of special tools for contractors' use. Cover, salmon-yellow and violet.]

The Cooper-Roberts Co., Mount Vernon, Ohio, U. S. A.=Catalogue 17 pp., 9″×6″. [Describing and illustrating the "Cooper" high speed self contained center-crank automatic engine, simple and compound; for electric light, street railway service, flouring mills, factories, &c.]

Sheffield Car Co., Three Rivers, Mich., U. S. A.=Catalogue, 96 pp., 6″×9″. [Describing a line of light cars and containing a full illustrated description of the works of the company. A very interesting catalogue, beautifully printed. Cover, robin's-egg blue and gold.]

The Hayden and Derby Manufacturing Co., New York, U. S. A.=Catalogue, 32 pp, 6″×9″. [Containing practical information about injectors, a few plain facts which are of interest to all steam-users, and illustrated descriptions of the injectors made by this company, including the Metropolitan Automatic Injectors described in full in the Department of Improved Machinery in the present number of this magazine.]

Joseph F. McCoy Co., New York. U. S. A.=Catalogue, 147 pp., 7″×10″, 1892. [Describes a long line of machinery and railroad specialties manufactured and sold by this company. The catalogue is excellently printed in blue, and the illustrations are very clear and neat. Cover, orange and black.]

The Standard Paint Co., New York, U. S. A.=Descriptive catalogue and price list, pages 9″×11¾″, unnumbered. [The text is interspersed with sheets of samples of the goods manufactured by this company, including high-grade building, sheathing, and insulating papers. These samples are for reference when specifications are drafted. The book is elegantly printed, and bound in stiff paper covers, blue and black.]

The Q. & C. Co., principal offices, Chicago, Ill., U. S. A., New York, U. S. A., and Montreal, P. Q, Can.=Catalogue, 32 pp., 7″×10″. [Describing a great variety of metal-sawing machinery designed and especially constructed and adapted to meet the requirements of steam railroads, street railways, bridge builders, structural iron works, rolling mills, shafting works, foundries, and all other users of metal, either cast or wrought iron or steel. Handsomely printed on coated paper, with *fin-de-siècle* covers.]

The Westinghouse Machine Co., Pittsburg, Pa, U. S. A.=(1) Pamphlet, 12 pp., 6″×3½″. [Economy vs. Guarantees of Engines. An essay intended to emphasize the question: "Which is most to your interest, a demonstration of true economy or an unfulfilled guarantee?"] (2) Pamphlet, 30 pp., 4½″×7″. [Practical Science, volume I, No. 1, devoted to the practical application of scientific electrical research. Price, $5.00 per year, 50 cts. a copy. A trade publication. This pamphlet, which is No. 1 of volume I of this trade publication, contains an essay on "Lightning Arresters, and Why They Sometimes Fail," by Alexander J. Wurts.]

The Prince Mfg. Co., New York, U. S. A.=Pamphlet, 32 pp., 5½″×9″. [The rusting of iron and steel, how it may be prevented, and how it is promoted; also Prince's Metallic Paint. Cover, robin's-egg blue.]

Purdue University.=Twelfth Annual Catalogue, 31 pp., 15½″×7¾″, 1895-1896.

Sulzer-Vogt Machine Co., Louisville, Ky., U. S. A.=Pamphlet, 20 pp., 6″×9″. [Describing and illustrating the electric elevators manufactured by this company. Cover, gray and blue.]

The Gould Coupler Co.=Catalogue 1893, 47 pp., 9″×12″, with supplement, 15 pp. [Contains a description of the Malleable Works of this company recently erected at Depew, N. Y., and also of the well known Gould's Steam Forge at Buffalo, N. Y., together with details of the various articles manufactured by this company. This is one of the handsomest catalogues that have recently come to our office. Printed on coated paper with ample and elegant illustrations, and bound in flexible covers, blue and gold. The supplement describes the Gould M. C. B. Freight Coupler, No. 8, Model of 1894; also the Gould M. C. B. Pilot Coupler and the Gould Freight Buffer, Model of 1894.]

W. D. Allen & Co., Chicago, Ill., U. S. A.= Catalogue No. 6, 240 pp., 6½″×10″, 1895. [Describes and illustrates an extensive line of rubber goods, including rubber belting, tools for belt work, belt clamps, rubber hose, etc., etc. Also an extensive line of leather belting, link belting, sprocket wheels, elevator machinery, steam and water fittings, engine governors, heating radiators, pulley blocks, tools and hardware, Babbitt metals, &c. This firm conducts the western salesroom of the New York Belting & Packing Co., Limited. Well printed and illustrated on good paper. Cover green and black.]

Campbell & Zell Co., Baltimore, Md., U. S. A.=How to Generate Steam Economically. A trade publication of 95 pp., 7″×10″, bound in stiff morocco. [The book discusses the principle of economical generation of steam, and also describes and illustrates minutely the Zell boiler with numerous illustrations of installments in important works. Numerous tables are presented, among which are a table of factors of evaporation, dimension tables of the boilers, table of percentage of fuel saved by heating feed water (steam at 60 pounds) size of chimneys for steam boilers of different rated powers, table of relative efficiency of non-conducting materials, etc.] (2) Leaflet entitled, "Some Little Things About Boilers," designed as a help in forming judgment as to the selection of boilers.]

The E. S. Greeley Co., New York, U. S. A.= Illustrated catalogue and price list, 560 pp., 6″×9″. [Describes and illustrates one of the most extensive lines of electrical supplies carried by any house in the world. It is significant of the extent of the growth of the electrical industries that a catalogue of this magnitude should be necessary to list the various appliances needed in them. Price lists accompany the descriptive text. Cover, buff and black.]

BOOKS RECEIVED.

Annual Report of the Board of Public Works of the city of Milwaukee, for the year ending December 31, 1894. Milwaukee: Ed. Keogh, 386-388 Broadway, 1895. [240 pp., 6″×9″, paper.]

Bulletin No. 9, United States Department of Agriculture, Division of Forestry. Report on the use of metal railroad ties and on preservative processes and metal tie plates for wooden ties. By E. E. Russell Tratman, A. M., Am. Soc. C. E. (Supplementary to Report on the Substitution of Metal for Wood in Railroad Ties, 1890.) Prepared under the direction of B. E. Fernow, chief of division of forestry. Published by authority of the secretary of agriculture, Washington: Government Printing Office, 1894. [363 pp., 6″×9″, paper.]

The Transit, volume 3, No. 1, January, 1895. Portland Cement. A monograph by Charles D. Jameson, Mem. Am. Soc. of C. E., professor of engineering, State University of Iowa, Iowa City. Published by the University of Iowa, 1895. [192 pp., 6″×9″, paper.]

Central Railway Club. Proceedings of the April meeting, 1895, held at the Hotel Iroquois, Buffalo, N. Y. Discussion and report of the committee on revision of the constitution and by-laws. Report of the committee on revision of the rules of interchange. [59 pp., 6″×9″, paper.]

Proceedings of the Electrical Society of Cornell University, 1894-1895, volume 2, Ithaca, N. Y.: Andrus & Church, 1895. [120 pp., 6½″×9½″, cloth.]

The Origins of Invention: a Study of Industry among Primitive Peoples. By Otis T. Mason, A. M., Ph. D., curator of the department of ethnology in the United States National Museum, Smithsonian Institution, Washington, D. C., U. S. A., with illustrations. London: Walter Scott, Ltd., Paternoster square. Imported by Charles Scribner's Sons, New York, 1895. [419 pp., 4¾″×7¼″. Cloth, price $1.25.]

On Bathing and Different Forms of Baths. By William Paul Gerhard, C. E., consulting engineer for sanitary works, author of "Hints on Drainage and Sewerage of Dwellings," "A Guide to Sanitary House Inspection," "House Drainage and Sanitary Plumbing," etc., Reprinted from *Architecture and Building*, New York: William T. Comstock, 1895. [31 pp., 6″×9″, paper.]